

بسم الله الرحمن الرحيم

## Structural analysis

11  
750

تکلیل منشآت :- هر معرفه لغوی اراضیه بنا چه مع لغوی شؤ تره اخرجیه  
علی اقطاع (شکل منشأ) لیتم تصمیمیه بعد ذلک .

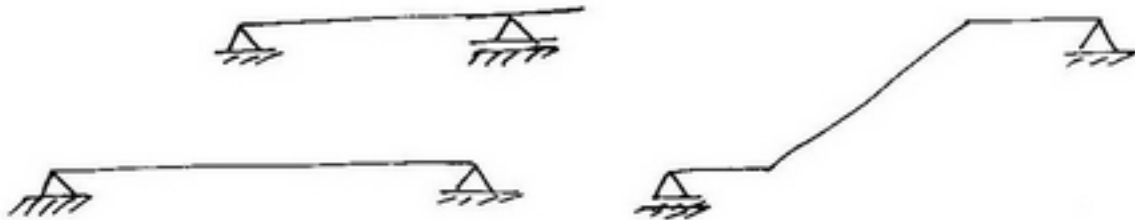
### ① type of structures

أنواع المنشآت

a- beams

الکمرات

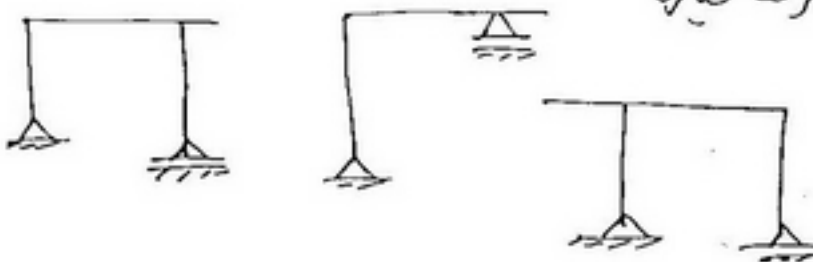
وهو نظام إنشائي عبارة عن عنصر أفقي مدد يكونه حائل مثل اسلم  
مددیم ترکیزه برکائز .



b- Frames

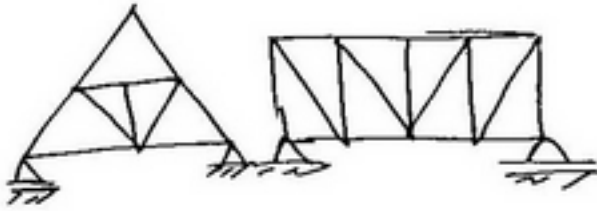
الابطارات

وهي عبارة عن كمالات ركائزها عبارة  
عن أعمدة



## المبانيات

### c trussed structures



وهي عبارة عن شبكة من العناصر  
تتميز بكثرة التحمل في جميع الاتجاهات  
حيث أنها كائنات التحمل في جميع الاتجاهات  
تعتبر من العناصر link members في نظام  
التحليل العنصري الإحصائي

### d - Arch structure

الكمرات المقوسة لتحمل الأحمال من  
أعلى بدلاً من وضعها، كائنات التحمل

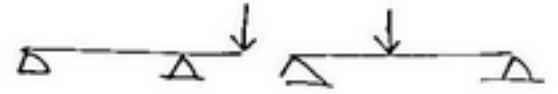
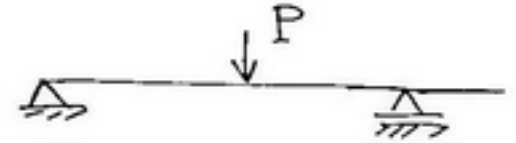


## ② shape of External loads

أنواع الأحمال المؤثرة على المنشآت  
السابقة .

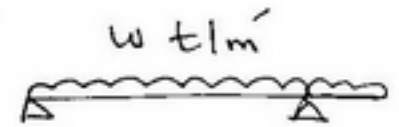
### (i) - Concentrated Load

حمل مركّز عند نقطة معينة  
قد يكون من نصف الكمر أو يكون عند أحد الطرفين



### (ii) - uniform Load

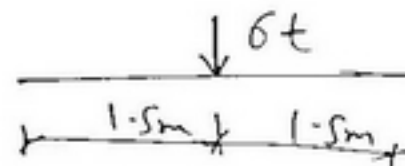
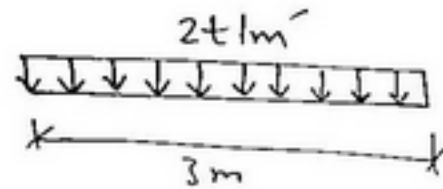
حمل موزع على كامل طول الكمر أو جزء معين منه  
وهو عبارة عن حمل مفرد على الكمر مثل وزن رمل  
على الكمر كلها مثلاً



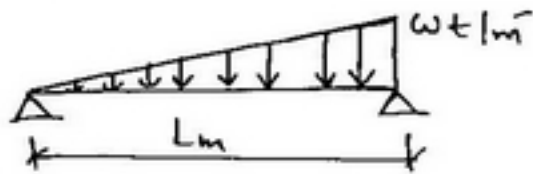
معنى ذلك أنه على كل متر يوجد ٦ طن  
ولكنه يتكاثف أو يستف

٥٥ كل كامل الكمر يتكون هناك ٣ \* ٢  
٦ =

بما أن تركيزها كالتالي ولكن من نصف  
الحمل موزع كل بعد ١.٥م



### (iii) - Trapezoidal load

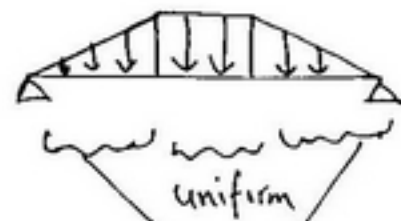
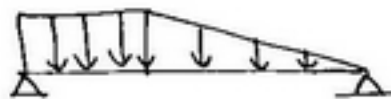


هو حمل يزداد من أمانته على الكمره

أمانته أعدي مثل حمل مثلث

\* نلاحظ انه الحمل في أمانته أكبر من الأخرى

مثل وضع شيكاه درأ و د متر ثم شیکار شده ثم ثلاثة

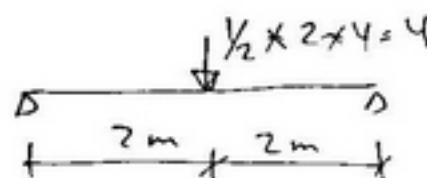
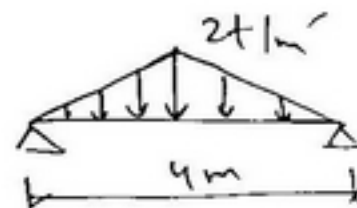
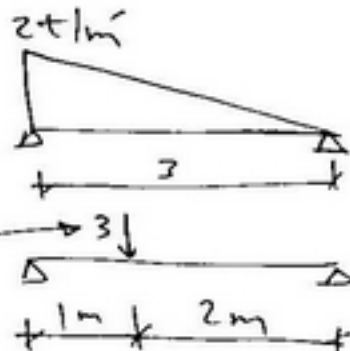


uniform

trapezoidal

دند تر کیزه ← استیکیل من نصفه

← مثلک من مثلک من ناصبه ایته البیره



نصفه  
بکوره  
نصفه



### 3 - loads

\*\* من انقطه سابقه عرفنا أشكال الاحمال ، لكن مسببات الاحمال  
هناك :-

#### (i) dead load

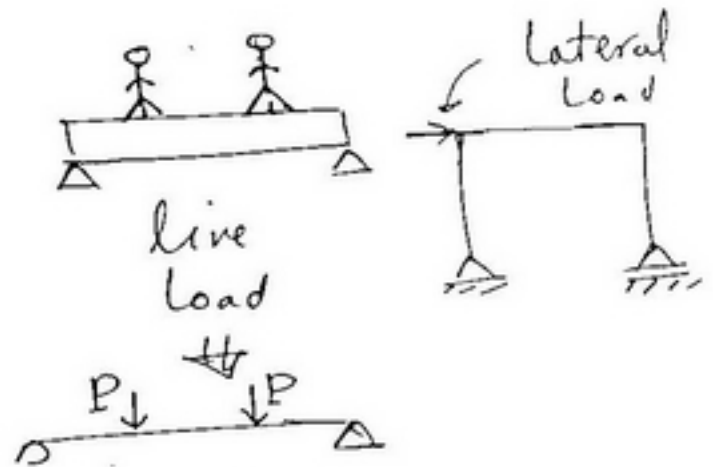
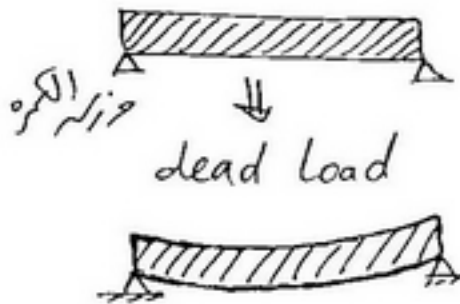
الحمل الناتج عن وزنه الكبره فقط ( ليس الحمل الحى ) لو وضعنا قلمه  
بيدك من جسر ترعه كبرت فلا تقوس ، وقد كبرت فليس كسر حتى لو غير  
ساره عليه وذلك بسبب وزنها .

#### (ii) live load

الحمل الحى وهو ناتج عن وجود أشخاص  
تتحرك على هذا الجس

#### (iii) lateral load

الاحمال السابقه تكونه اساسيه كل اقطاع ( ما هذا النوع من الاحمال يكونه  
افترق موازى لسطح الجدران يأتى بسبب الزلزال ورياح .



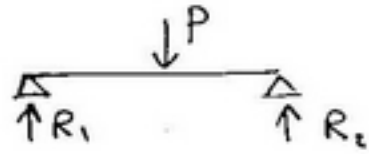
## 4-supports

## الركائز

هذه الدة تحمل شيئاً بالذ حال الاتية عليه .

نيز مستقر مستعجه هذه الكره لاسفل .

انما هذا خال الكره مستقره صبي تحمل الركائز الحمل  
من الاتية لعكس صان تكونه كصورة الاحمال



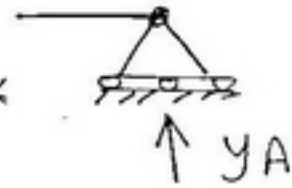
هنا =

$$R_1 + R_2 = P$$

من هذه النقطة سيتم شرح معنى الركائز ، كيفية وجودها في الطبيعة .

## Roller support

هذه الركيزة مسموح لها بالتحرك في الاتجاه الافقي  
بالتالي لا يوجد عليها رد فعل معاكس في الاتجاه الافقي

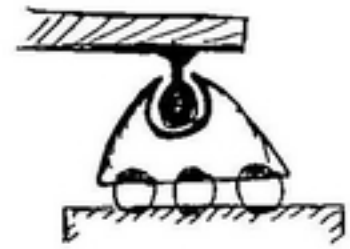
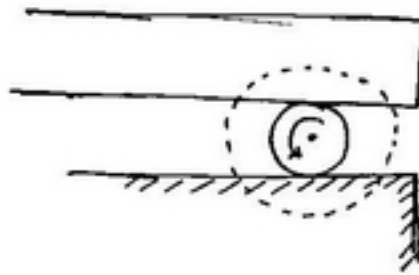


مسموح لها بالدوران عند نقطة التماسها بالكره  
بالتالي فلا يوجد رد فعل مقاوم للدوران

امان في الاتجاه الرأس فغير مسموح لها بالتحرك الافقي  
وهو يوجد عليها رد فعل رأس

YA

\*\* توجد هذه الركيزة في الكباري بنفس الشكل التالي

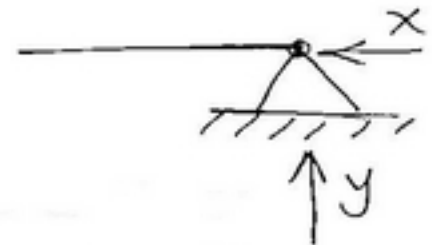


## 2) hinged support

\* مسموح لها الدوران فقط .

\* غير مسموح لها الحركة الرأسية (y)

وحرارة الانحناء (x)



\* أكثر الأمثلة الشبيهة له في الواقع ارتباط المركبة بالعمود

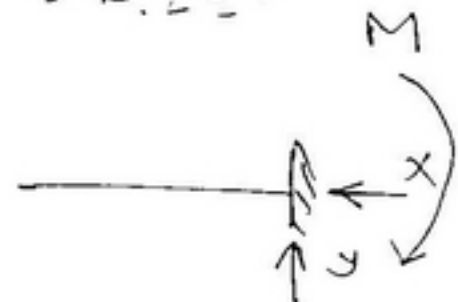
حيث يعتبر العمود ركيزة جنباً إلى جنبه .

## 3) Fixed support

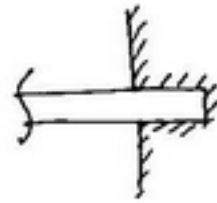
\* غير مسموح لها الحركة الرأسية  $y \uparrow$

الانحناء  $x \rightarrow$  " " " " " "

الدوران  $M \curvearrowright$  " " " " " "



فیر مسرور بالحرکه از اسبیه، لانتقیه، لاورانه

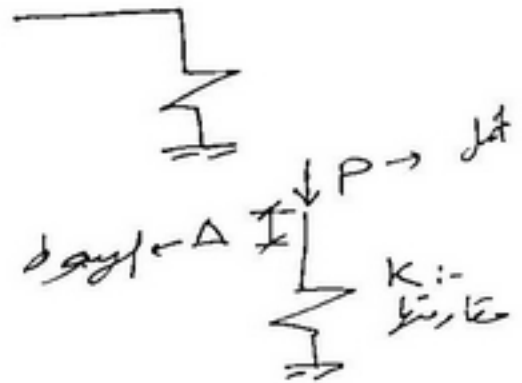


#### 4-5 spring support

هشجیه بار Roller لیکن

یدت هبوط کنده

$$K = P/\Delta$$



غیر متراشه نه منوج استه دی

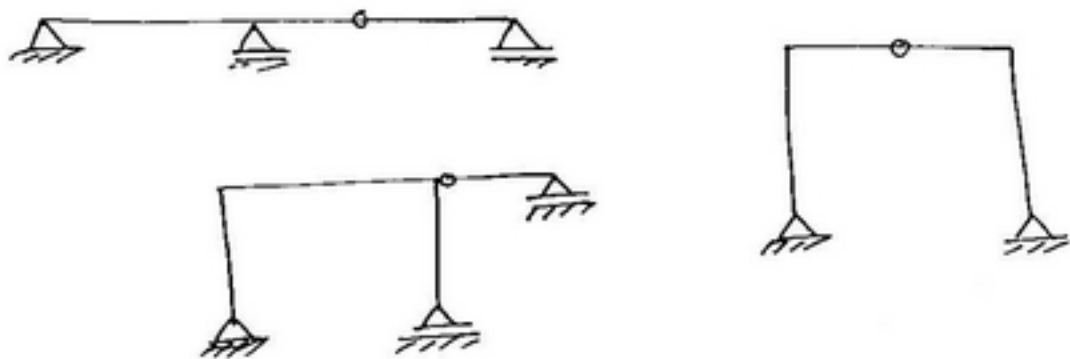
## 5-Intermediate hinge

مفصله

تستندم لتقرير العزم عند نقطه الكسر ومن تشبيهه بنوع مفصل عادي  
ربائتي نياحه العزم تكون معروفه عند هذه النقطه = صفر

$$\sum M_{@point} = zero$$

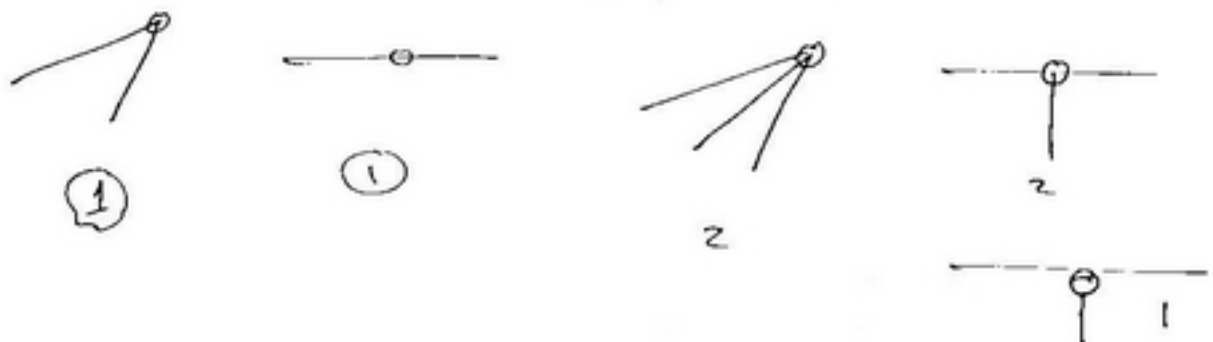
ربائتي مفرد تنزود معادله اضافيه كل معادلات ايزترانه اثنان



لاحظ اننا لو ربطت كغيره تنزود معادله اضافيه  
ثلاثه عناصر تنزود معادله اضافيه

نرى عدد العناصر التي اشتركت فيها ونطرح واحد ويكون

عدد المعادلات الإضافيه



## determination of Reaction

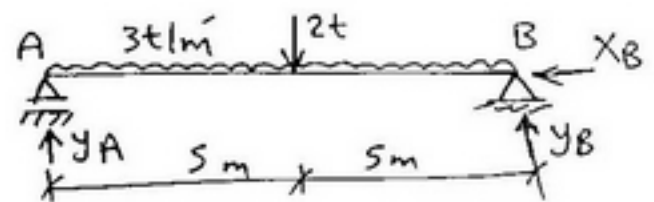
2

طريقة إيجاد Reaction النتيجه للتركائز :-

لقيم استخدام اشلات معادلات

$$\begin{cases} \Sigma X = 0.0 \\ \Sigma Y = 0.0 \\ \Sigma M = 0.0 \end{cases}$$

Example ①



$$* \Sigma X = 0.0$$

$$\Rightarrow X_B = 0.0$$

$$* \Sigma M_A = 0.0$$

$$\Rightarrow 2 \times 5 + 30 \times 5 - Y_B \times 10 = 0.0$$

$$\Rightarrow Y_B = 16 \text{ ton}$$

$$* \Sigma Y = 0.0$$

$$\Rightarrow Y_A + 16 = 2 + 30 \Rightarrow Y_A = 16 \text{ t}$$



لاحظ أن هذا المنشأ متماثل من مركز الأحمال وبالتالي فإن كل support يأخذ مثل الآخر.

$$y_A + y_B = 30 + 2$$

$$y_A = y_B$$

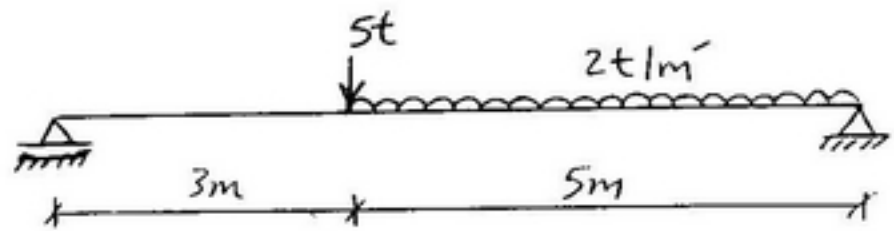
$$\Rightarrow y_A = y_B = \frac{32}{2} = 16 \text{ ton}$$



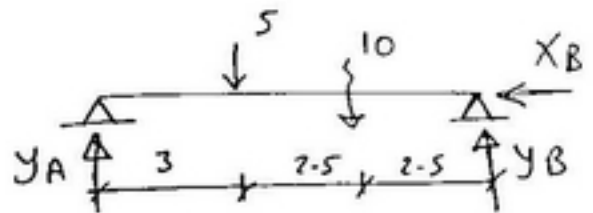
$$\begin{bmatrix} X_A \\ y_A \\ y_B \end{bmatrix} = \begin{bmatrix} 0 \\ 16 \\ 16 \end{bmatrix}$$

## Example 2

3



- Sol -



$$* \sum X = 0.0$$

$$X_B = 0.0$$

$$* \sum M_A = 0.0$$

$$5 \times 3 + 10 \times 5.5 = Y_B \times 8$$

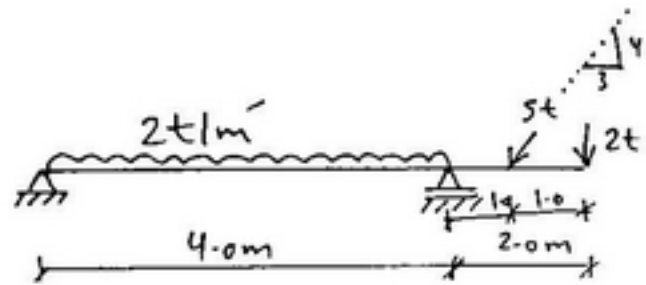
$$\Rightarrow Y_B = 8.75 \text{ ton}$$

$$* \sum Y = 0.0$$

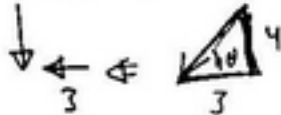
$$Y_A + Y_B = 15$$

$$\text{so } Y_A = 15 - 8.75 = 6.25 \text{ ton}$$

# Example 3



$$5 \sin \theta = 4$$

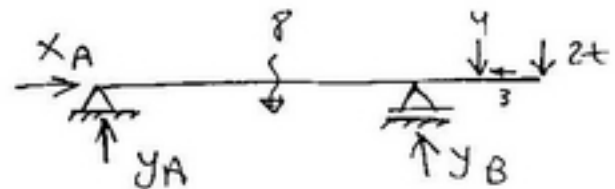


$$\theta = \tan^{-1} \frac{4}{3} = 53.13$$

$$\cos \theta = 0.6$$

$$\sin \theta = 0.8$$

— Sol —



$$\ast \sum F_x = 0.0$$

$$X_A = 3.0 \text{ ton}$$

$$\ast \sum M_A = 0.0$$

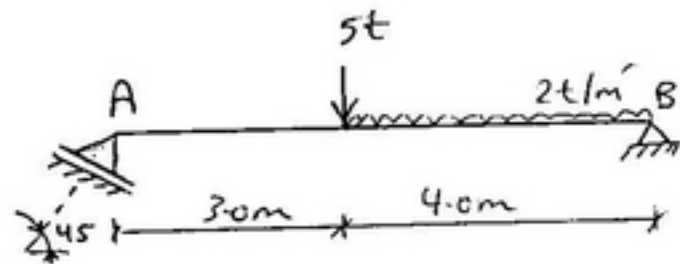
$$8 \times 2 + 4 \times 5 + 2 \times 6 = Y_B \times 4$$

$$\Rightarrow Y_B = 12 \text{ ton.}$$

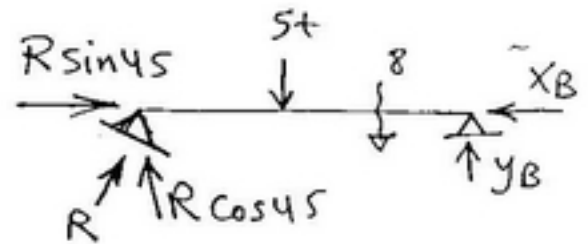
$$\ast \sum F_y = 0.0$$

$$Y_A = 8 + 4 + 2 - 12 = 2 \text{ t}$$

## Example



— Sol —



$$* \sum M_A = 0$$

$$5 \times 3 + 8 \times 5 - Y_B \times 7 = 0$$

$$Y_B = 7.86 \text{ ton}$$

$$* \sum Y = 0$$

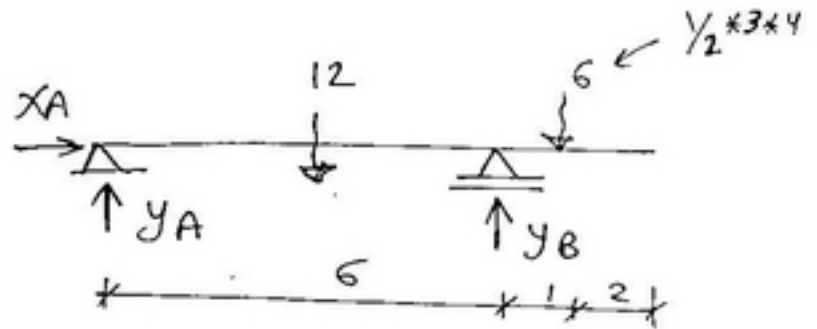
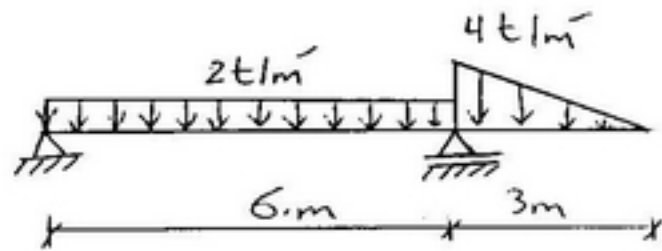
$$R \cos 45 = 13 - 7.86$$

$$\therefore R = 7.27 \text{ ton}$$

$$* \sum X = 0$$

$$X_B = R \sin 45 = 5.14 \text{ ton}$$

# Example



$$\sum X = 0$$

$$\therefore X_A = 0$$

$$\sum M_A = 0$$

$$12 \times 3 + 6 \times 7 = Y_B \times 9$$

$$\therefore Y_B = 13 \text{ ton}$$

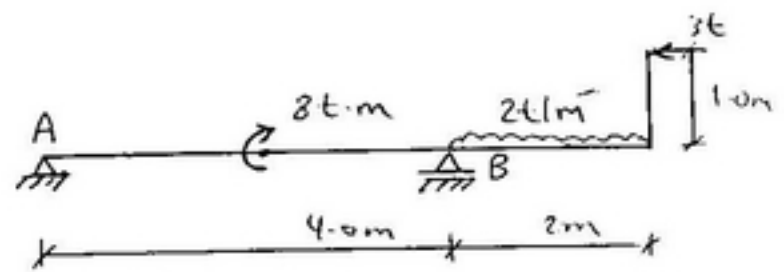
$$\sum Y = 0$$

$$Y_A + Y_B = 12 + 6$$

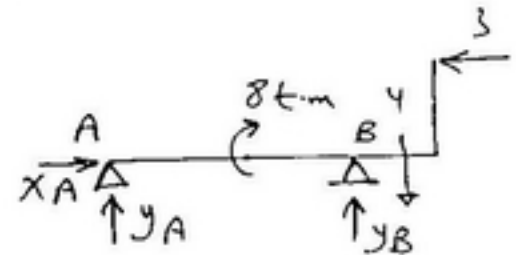
$$Y_A = 5 \text{ ton}$$

## Example

7



— Sol —



$$\sum X = 0 \dots$$

$$\Rightarrow X_A = 3 \text{ ton.}$$

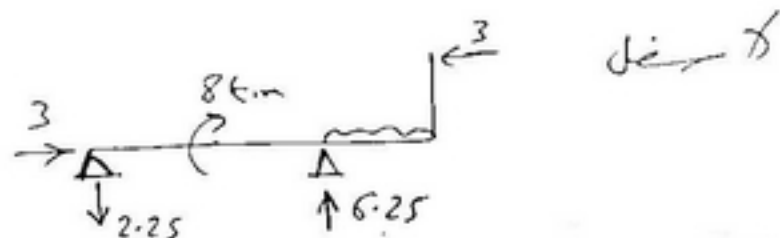
$$\sum M_A = 0 \dots$$

$$\Rightarrow 8 + 4 \times 5 - 3 \times 1 = Y_B \times 4$$

$$\Rightarrow Y_B = 6.25 \text{ ton.}$$

$$\sum Y = 0 \dots$$

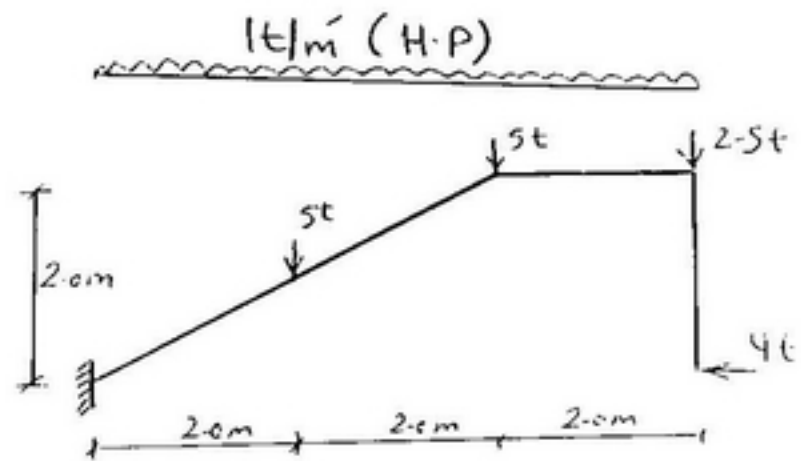
$$\therefore Y_A = 4 - 6.25 = -2.25 \text{ ton}$$



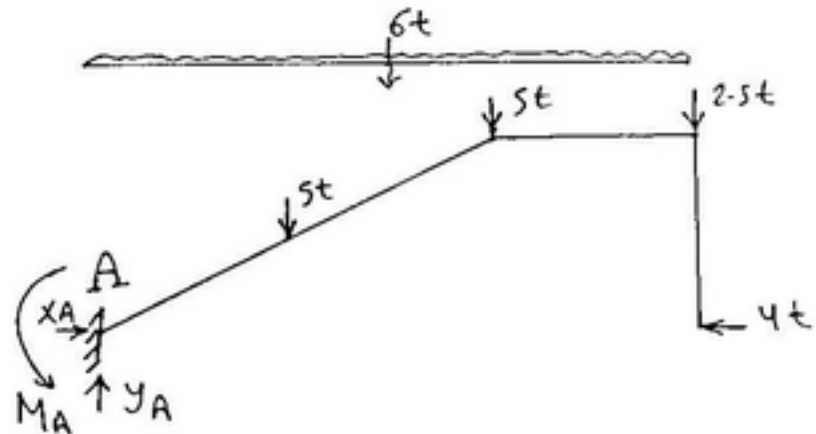


### Example

8



— Sol —



$$* \sum X = 0.0$$

$$X_A = 4 \text{ ton}$$

$$* \sum Y = 0.0$$

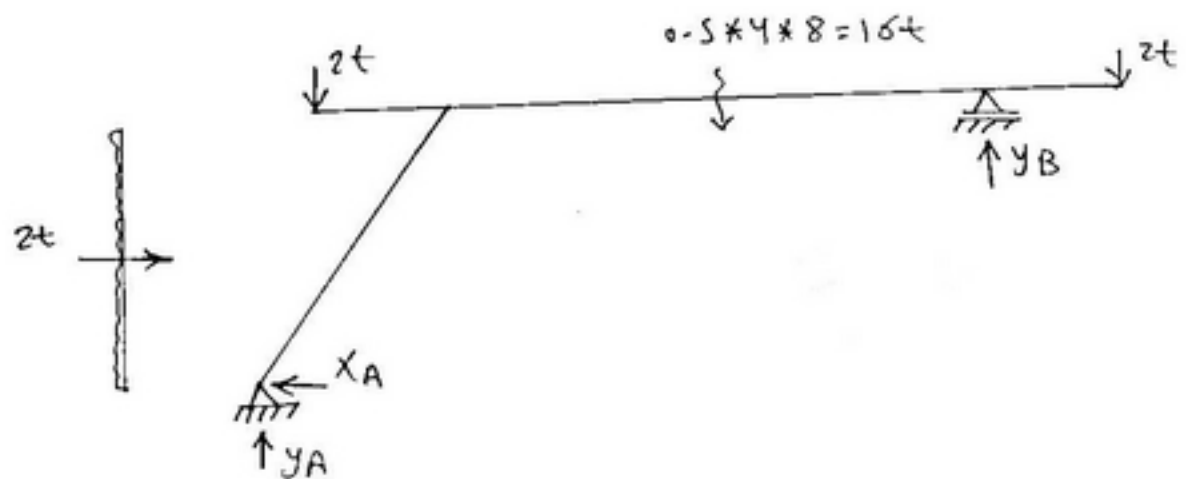
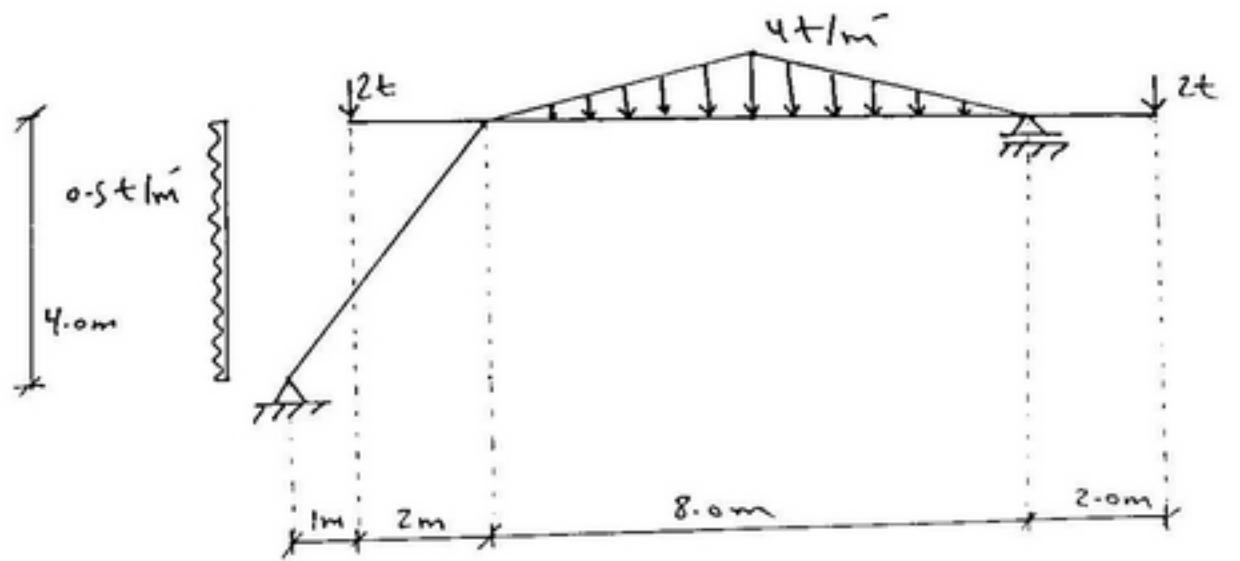
$$Y_A = 5 + 5 + 2.5 + 6 = 18.5 \text{ ton}$$

$$* \sum M_A = 0.0$$

$$M_A - 6 \times 3 - 5 \times 2 - 5 \times 4 - 2.5 \times 6 = 0.0 \Rightarrow M_A = 63$$

$$\therefore M_A = 63 \text{ t.m}$$

(8)

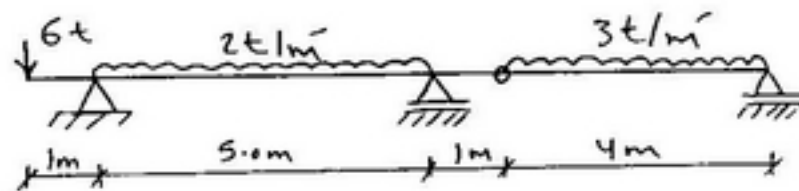


$$\sum X = 0 \Rightarrow X_A = 2 \text{ ton}$$

$$\sum M_A = 0 \Rightarrow 2 \times 2 + 2 \times 1 + 16 \times 7 + 2 \times 13 = Y_B \times 11$$

$$\Rightarrow Y_B = 13.1 \text{ ton}$$

$$\sum Y = 0 \Rightarrow Y_A = 2 + 16 + 2 - 13.1 = 6.9 \text{ ton}$$

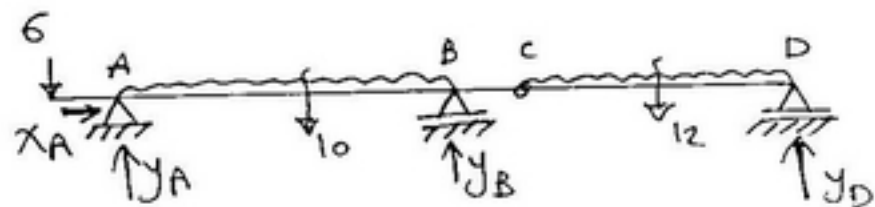


\* حالة "Intermediate hinge" هناك طريقتين للتحليل:-

الطريقة الأولى

يتم عمل إثنين معادلات  $\rightarrow$  يتم إضمانه معادلة (I. h) متر فذ

$$\sum M_{Left} = 0.0 \quad \text{أو} \quad \sum M_{right} = 0.0$$



$$* \sum M_{C, Right} = 0.0$$

$$\Rightarrow Y_D \times 4 = 12 \times 2$$

$$\Rightarrow Y_D = 6 \text{ ton.}$$

$$\times \sum X = 0.0$$

$$\Rightarrow X_A = 0.0$$

$$\times \sum M_A = 0.0$$

$$-6 \times 1 + 10 \times 2.5 + 12 \times 8 - 6 \times 10 - Y_B \times 5 = 0.0$$

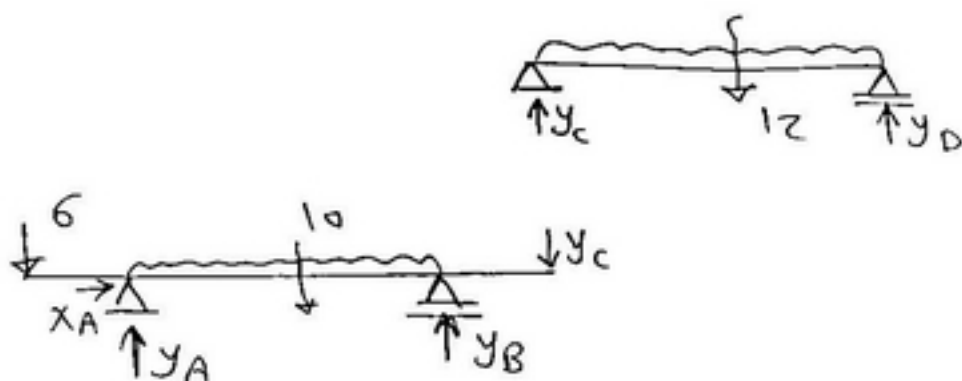
$$\Rightarrow Y_B = 11 \text{ ton}$$

$$\times \sum Y = 0.0$$

$$\Rightarrow Y_A = 6 + 10 + 12 - 11 - 6$$

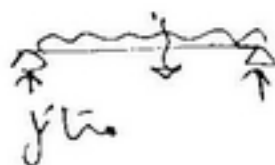
$$= 11 \text{ ton}$$

الطريقة الثانية  
 دهر فصل لنشأ مع بعض دسيم رفع لنقل شيئاً لا تلامس  
 وضع لنشأ Free مع hinge دسيم إرتداد  
 Reaction لنشأ مع تلامس مع الكمره المستقيمة

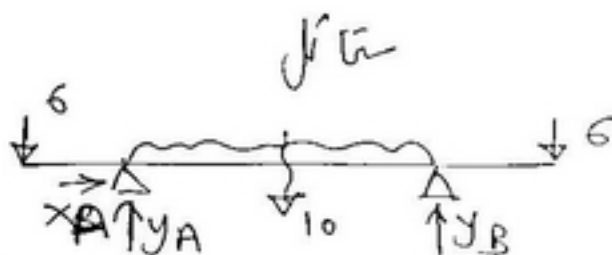


Part C-D

$$Y_C = Y_D = \frac{12}{2} = 6 \text{ tons}$$



Part A-C

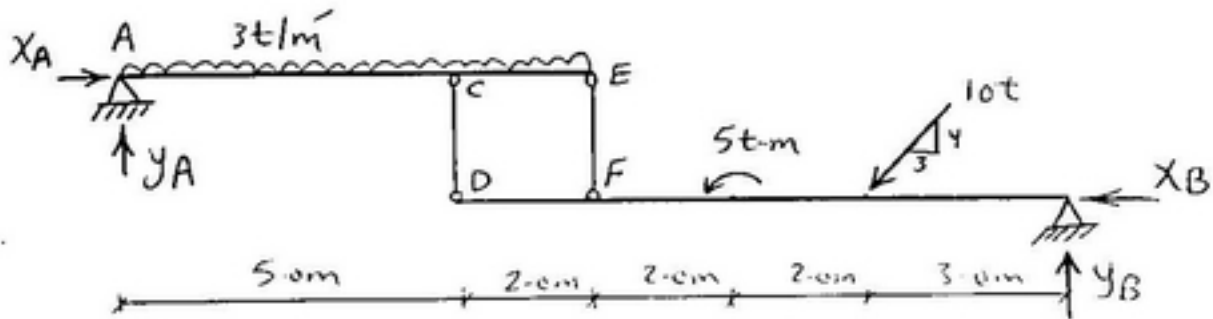


$$\therefore Y_A = Y_B = \frac{6+6+10}{2} = 11 \text{ tons}$$

$$\sum X = 0 \Rightarrow X_A = 0$$

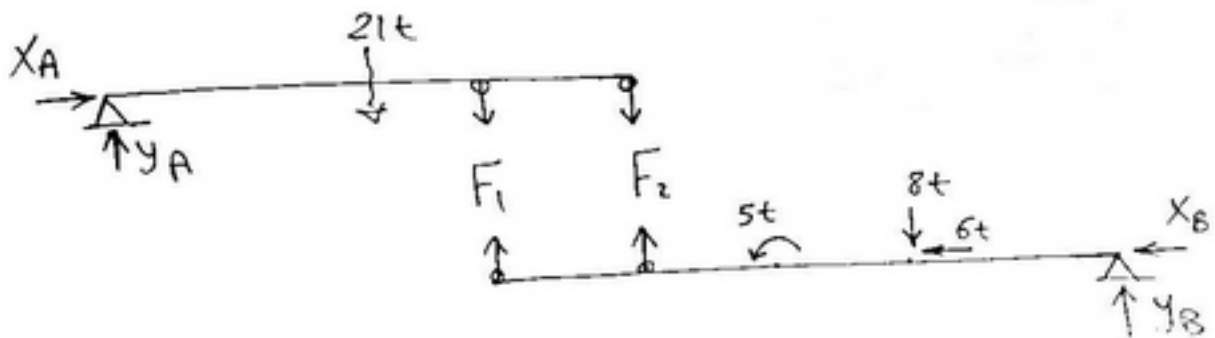


(12)



\* عندما تجد عنصر بين اثنين In intermediate يتدرج في هذا العنصر قوة  
واحدة في اتجاهه \* هذا الشكل مكرره مع مشاييم ( 6 معادلات )

مبني على [ 7 مافييل ]



Part A → E

$$X_A = 0.0$$

Part D → B

$$X_B = -6 \text{ ton}$$



For part ①

$$\rightarrow \sum M_A = 0.0$$

$$21 \times 3.5 + 5F_1 + 7F_2 = 0.0$$

$$5F_1 + 7F_2 = -73.5 \longrightarrow \textcircled{1}$$

For part ②

$$\rightarrow \sum M_B = 0.0$$

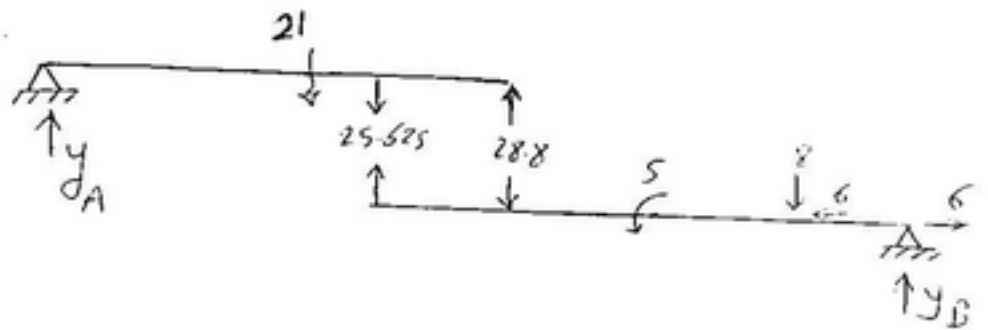
$$8 \times 3 + 5 - 7F_2 - 9F_1 = 0.0$$

$$9F_1 + 7F_2 = 29 \longrightarrow \textcircled{2}$$

∴

$$F_1 = 25.625 \text{ ton}$$

$$F_2 = -28.8 \text{ ton}$$



Part ①

$$y_A = 21 + 25.625 - 28.8 = 17.825 \text{ t}$$

Part ②

$$\begin{aligned} y_B &= 28.8 + 8 - 25.625 \\ &= 11.175 \text{ ton} \end{aligned}$$

OK

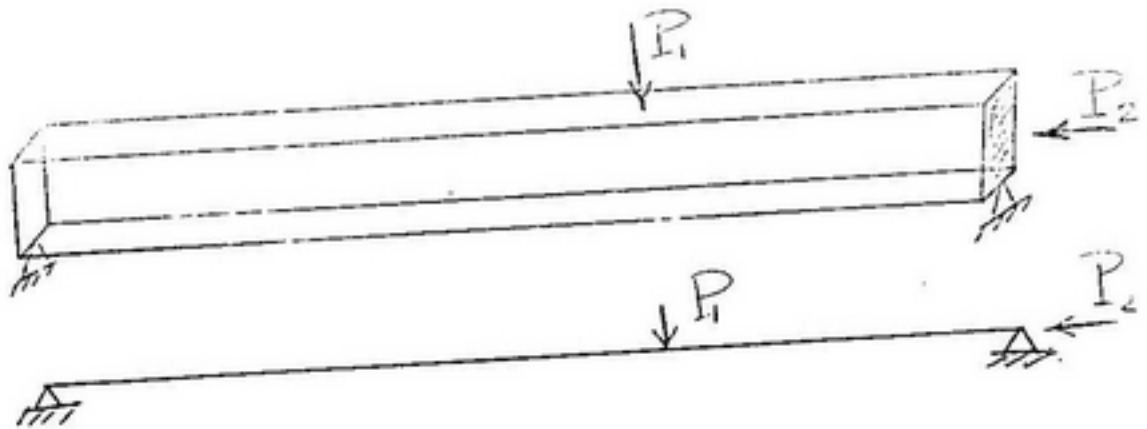
مکملہ درجہ

# Internal forces

بقوت لداصلیہ بقولہ دافل لکمران وەر بسبب بقوت لداصلیہ و هذا ما يسببه  
وهو ان الضغط ← normal force وەر بقوت موازی للکمر

وەر بقوت موازی للکمر ← shear force وەر بقوت موازی للکمر

وەر بقوت موازی للکمر ← Bending diagram وەر بقوت موازی للکمر



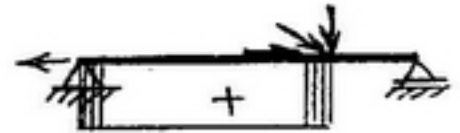
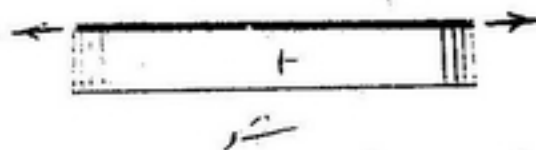
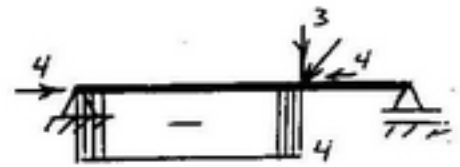
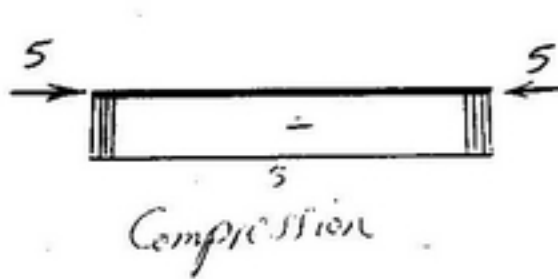
$P_1 \rightarrow$  موازی للکمر وەر بقوت موازی للکمر

$P_2 \rightarrow$  موازی للکمر وەر بقوت موازی للکمر

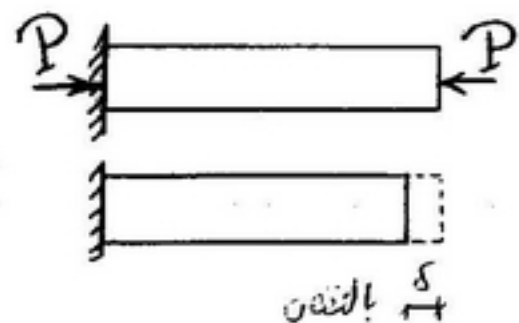
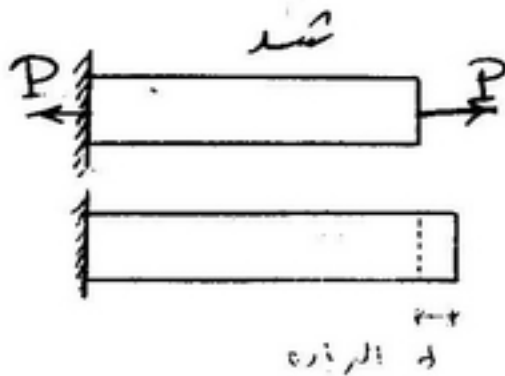
# ① normal force

\* هوسد اوضفط دل لكره و بكونه لقوة لقوة

موازى للكره و سم رسم ل normal بيه نقطتين لقوة لقوة



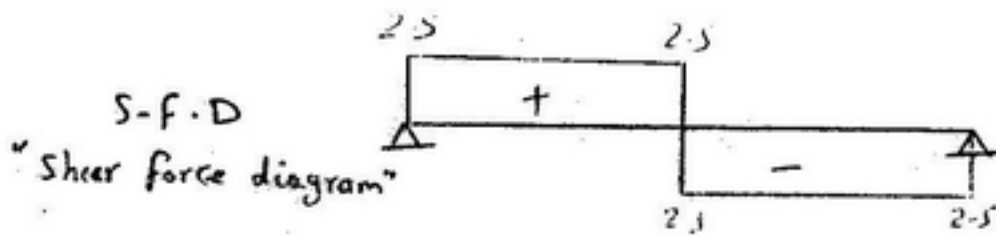
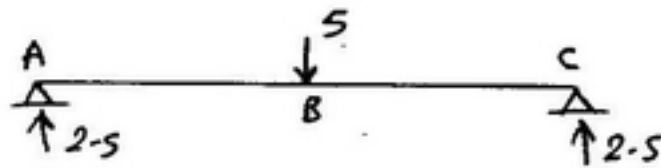
تأثير normal force دل لكرات



## ② Shear force diagram

قوى القص المولدة داخل الكمر

رسم قوى موازية للقطاع عمودياً على الكمر الموضوح



الرسم S.F.D

١- نبدأ من الشمال ونختر مع اتجاه القوة باتجاه اليسار.

مثلاً هناك بسيط بأعلى ٥ مع اتجاه  $\uparrow 2.5$  لأننا نبدأ من A

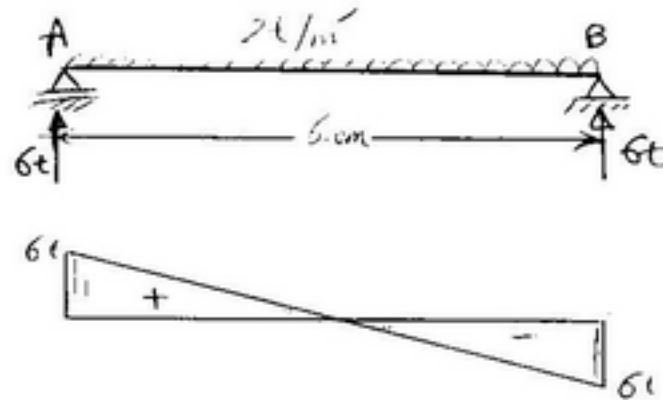
ثم تبقى ثابتة حتى B ونبدأ  $\downarrow 5$  لأننا ننتقل

حتى -2.5 - ثم تبقى ثابتة حتى C  $\leftarrow$

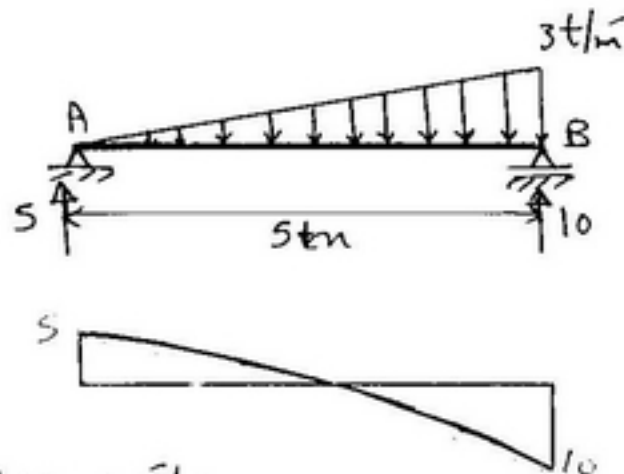
حتى تفصل C  $\leftarrow$  فيبقى  $\uparrow 2.5$  لأننا

نصل للصفر  $\Leftarrow$  لأننا نصل shear

\* مثال 4



نمودار محاله + مثال اساسه متوزع كل متر و بالتالي عند نقطة A  
 $6t$  لانه، وبالتالي يرتفع خط لأعلى  $6$  ثم ياتجا. B ← كل متر تبد  
 $2t$  لا تسفل صفر يكتحل  $12t$  لا تسفل عند المركز فينزل ايسر  
 $6t$  سالب، ولكن يكتوه خط مائل (لانه كل متر  $2t$ ) لا تسفل



\* Trapezoidal

لنوصل به 5 و 10 ليس خط لانه عدل التحيل متزايد من B ← A

العديب لانه لانه متزايد باتجاه B ، لكانه لكانه [



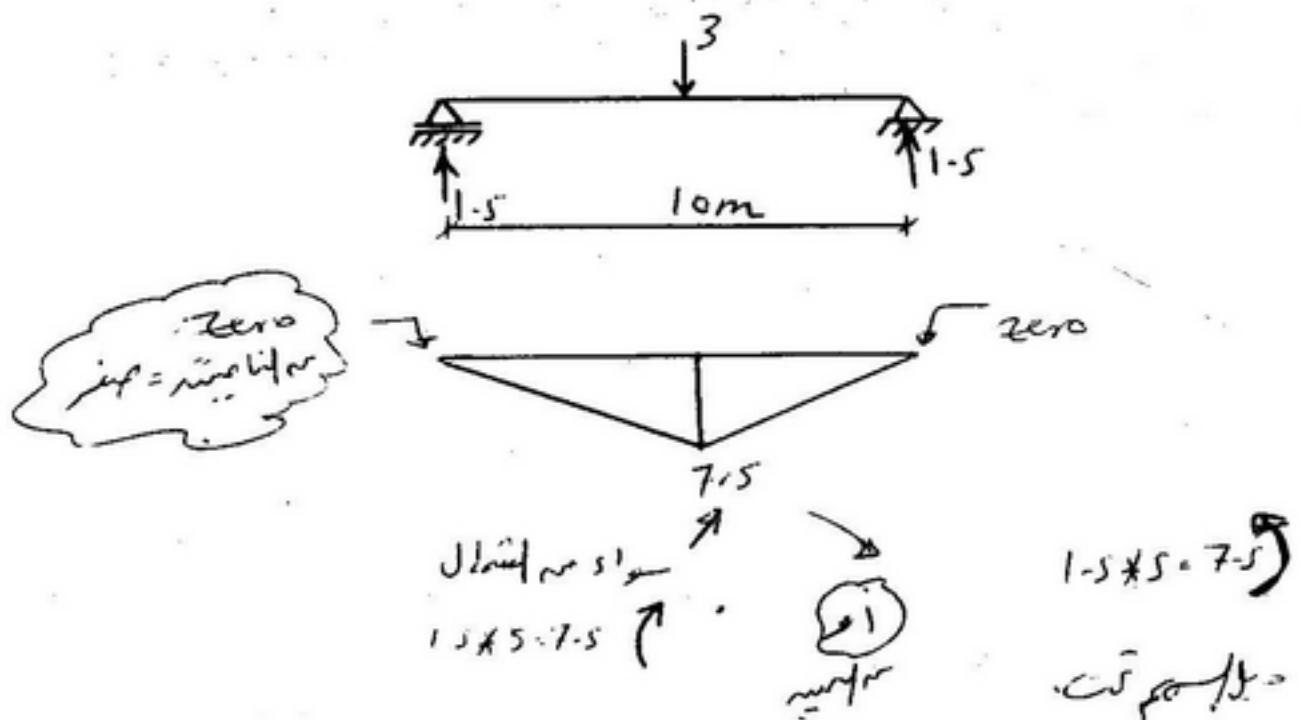
### ③ Bending moment diagram

العزم هو عبارة عن القوة \* المسافة  
وحساب العزم سوار كانه من الجبهة الى اليسار ، ويتم وضع كت اذقوة

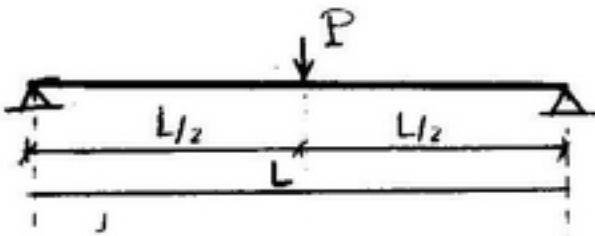
لل اساس ←  
↑ كت  
↓ عزم

يتم وضعه مع ديل اسهم  
↑ كت  
↓ عزم

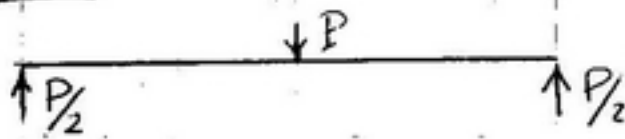
\* كندا يكون هناك عمل سوزع يتم حساب العزم من بداية الخانة ومنتهى



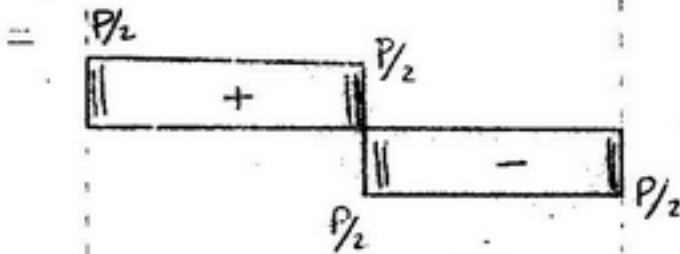
بعض اشكال الحفوفه



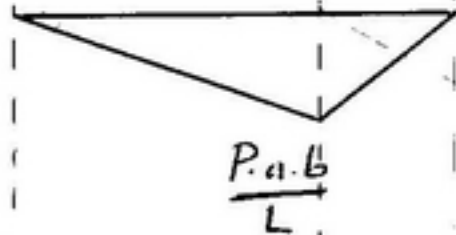
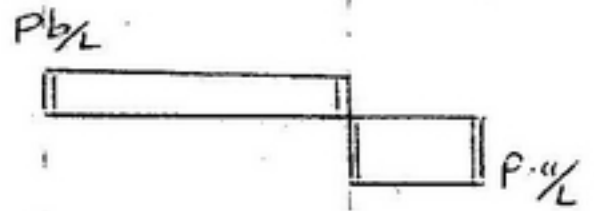
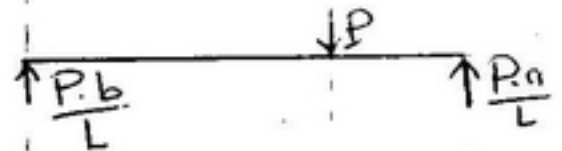
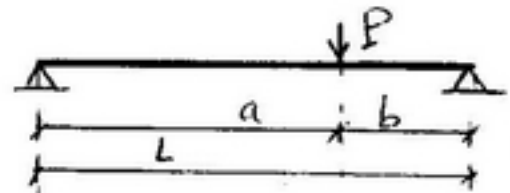
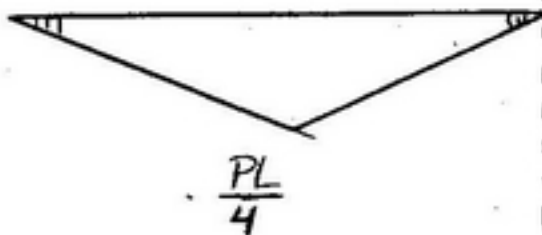
Reaction

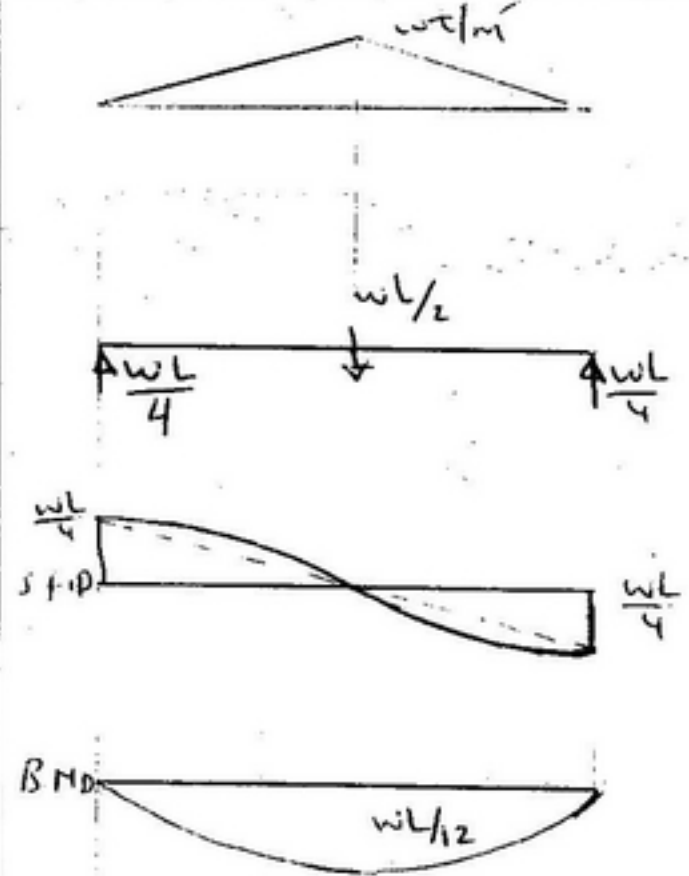
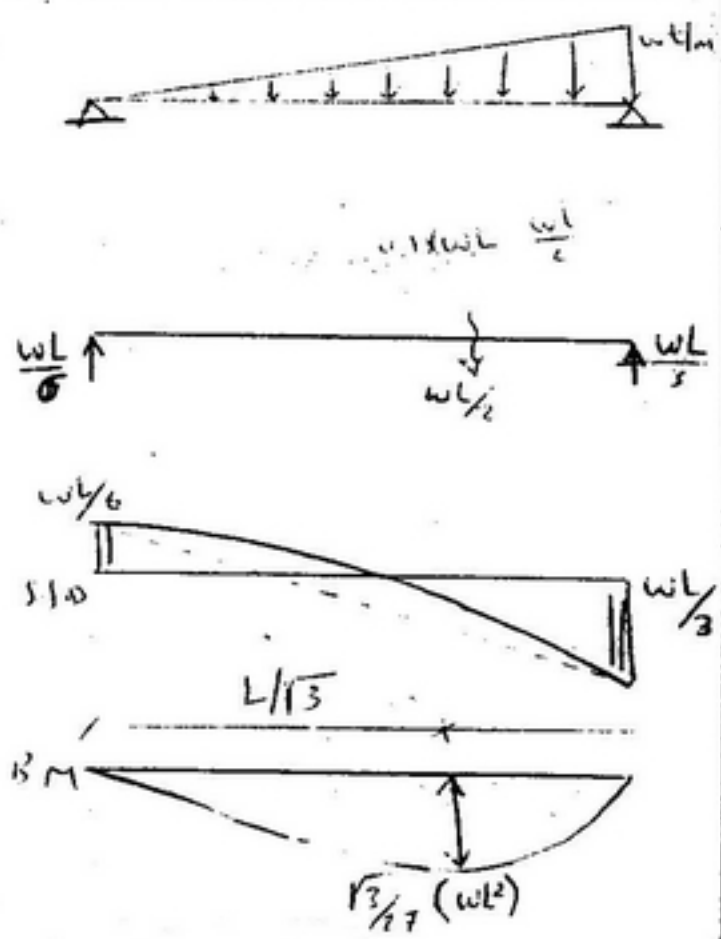
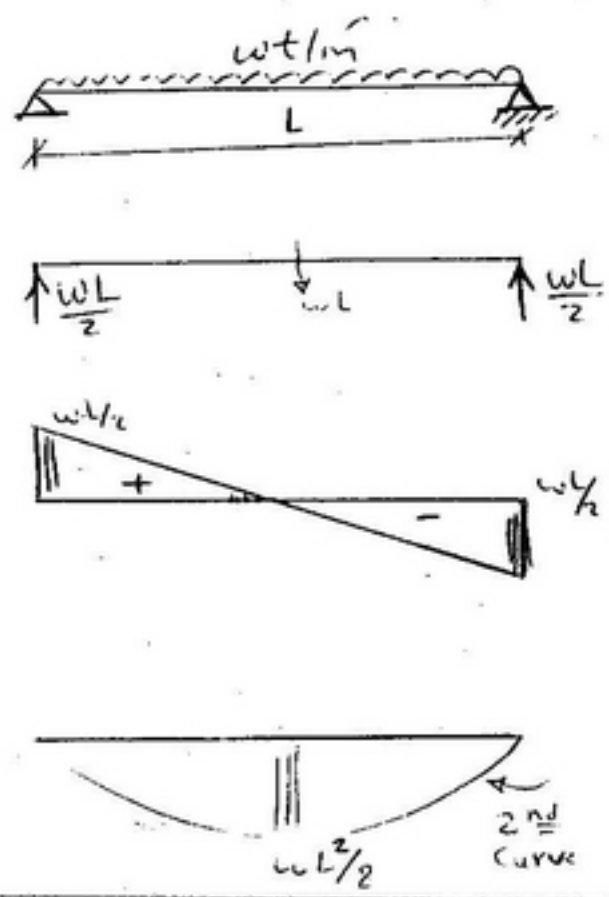
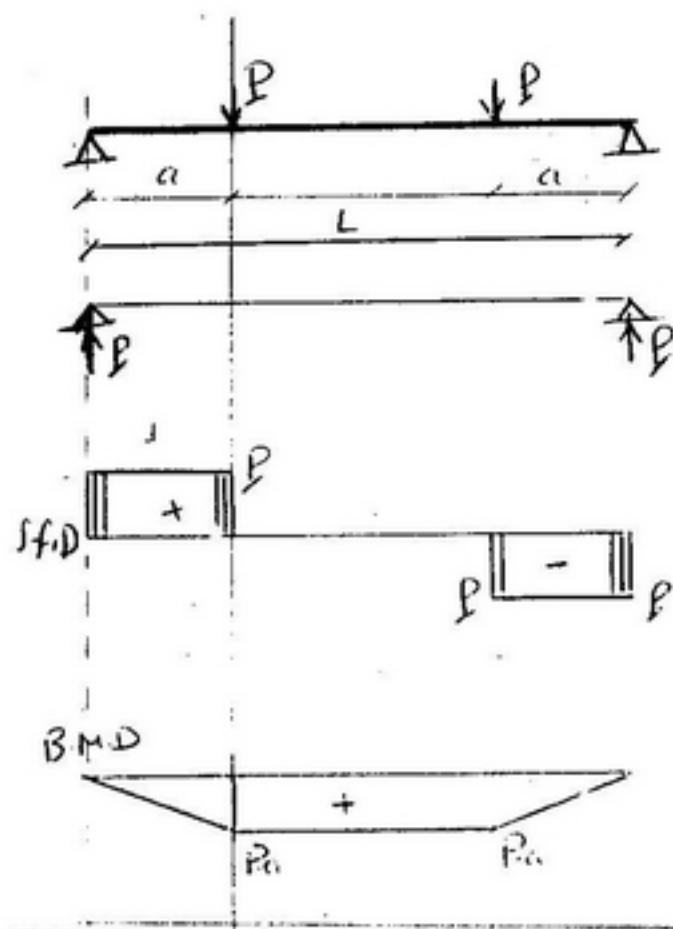


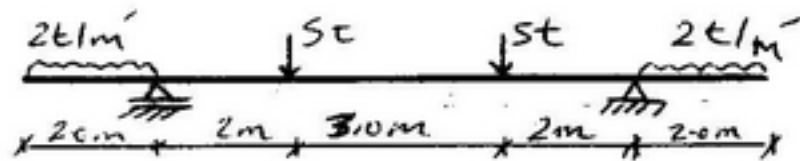
S.F.S



B.M.D







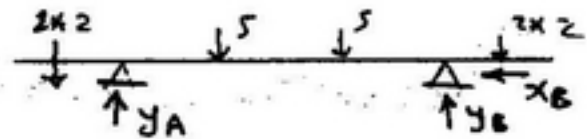
for the following beam

- its Required :- (i) Find all Reactions  
(ii) draw N.F.D, S.F.D and B.M.D

— sol —

1- For Reaction

from symmetry



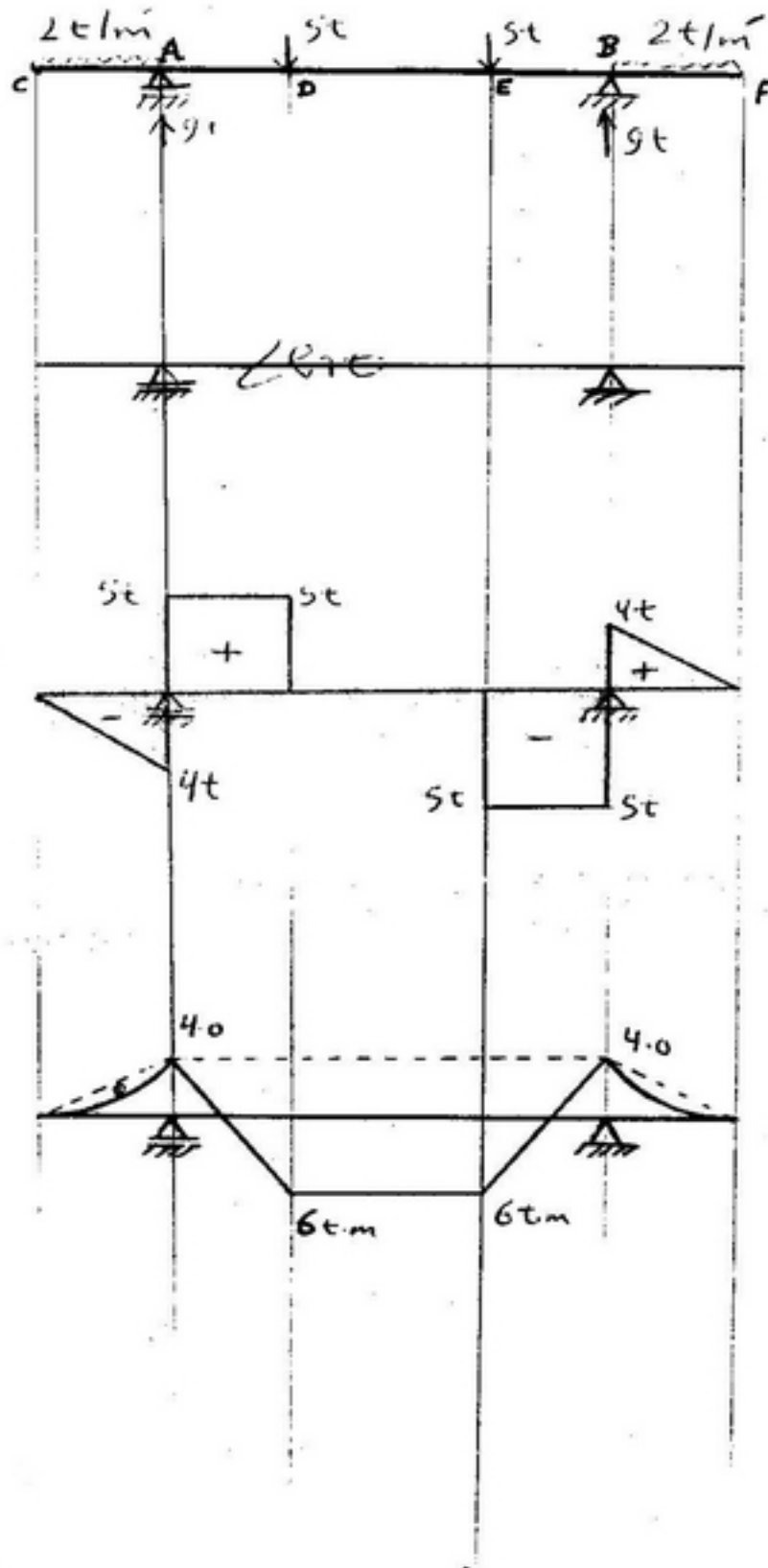
$$\therefore Y_A = Y_B = \frac{(2 \times 2) \times 2 + 10}{2} = 9 \text{ ton}$$

$$\sum X = \dots \Rightarrow X_B = \dots$$

NFD

S.F.D

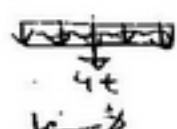
BMD



لرسم اینشتین

### III S.F.D

\* at C  $\rightarrow$  zero

\* From (C  $\rightarrow$  A)   $\rightarrow$  فصلی 4t لا عمل  
کند A را تمام طول پیرامون مائل  
لا عمل  
لا عمل

\* At A  $\rightarrow$   $9t \uparrow$   $\therefore$  Result  $= -4 + 9 = 5t$  (موجب)

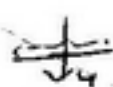
\* From A  $\rightarrow$  D no forces  $\therefore$  constant  $[5t \uparrow]$

\* at D  $5t \downarrow$   $\rightarrow$  تلاشی  $5t \downarrow$  &  $5t \uparrow$   $\rightarrow$  صفر

\* Constant zero from D  $\rightarrow$  E

\* at E  $5t \downarrow$   $\rightarrow$  Result  $(-5)$  continue constant  
to B

\* at B  $9t \uparrow$   $\therefore$  Result  $(4t \uparrow)$

\* from B  $\rightarrow$  F uniform  $2t/m$  

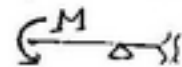
$\therefore$  closed zero at (F)

## 2) B.M.D

\* at C  $\rightarrow$  zero

(لا يوجد عزوم هنا)

بما أن العزوم موجودة في مركز



\* at A  $\rightarrow$

$$M_A = 4 \times 1 = 4 \text{ kNm} \quad (4) \text{ كجم}$$

\* at D  $\rightarrow$

$$M_D = 4 \times 3 \downarrow + 9 \times 2 \uparrow$$

$$= 12 \downarrow + 18 \uparrow = 6 \uparrow \quad 6 \text{ كجم}$$

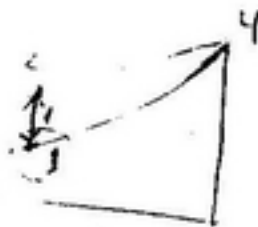
\* at L (from Right) such as  $M_D$

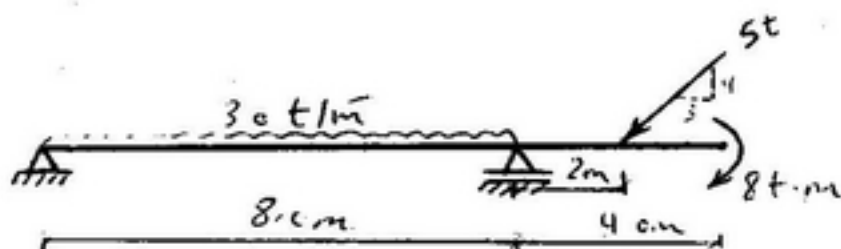
and so on at B & F.

$$\frac{wL^2}{8} = \frac{2 \times 2^2}{8} = 1$$



من منتصف الحمل الموزع

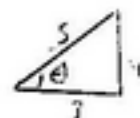




\* draw N/D, SFD and B.M.D

--- Sol ---

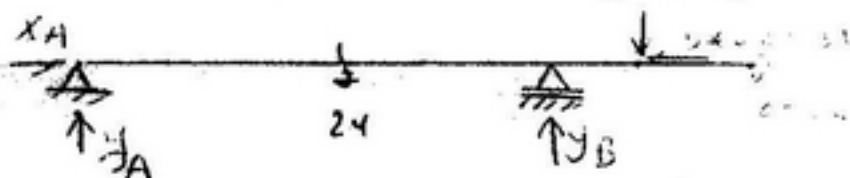
Reactions



$$\cos \theta = \frac{3}{5} \quad \text{and}$$

$$\sin \theta = \frac{4}{5}$$

$$5 \times \frac{4}{5} = 4 \text{ t}$$



$$\sum X = 0 \Rightarrow X_A = 3 \text{ t}$$

$$\sum M_A = 0$$

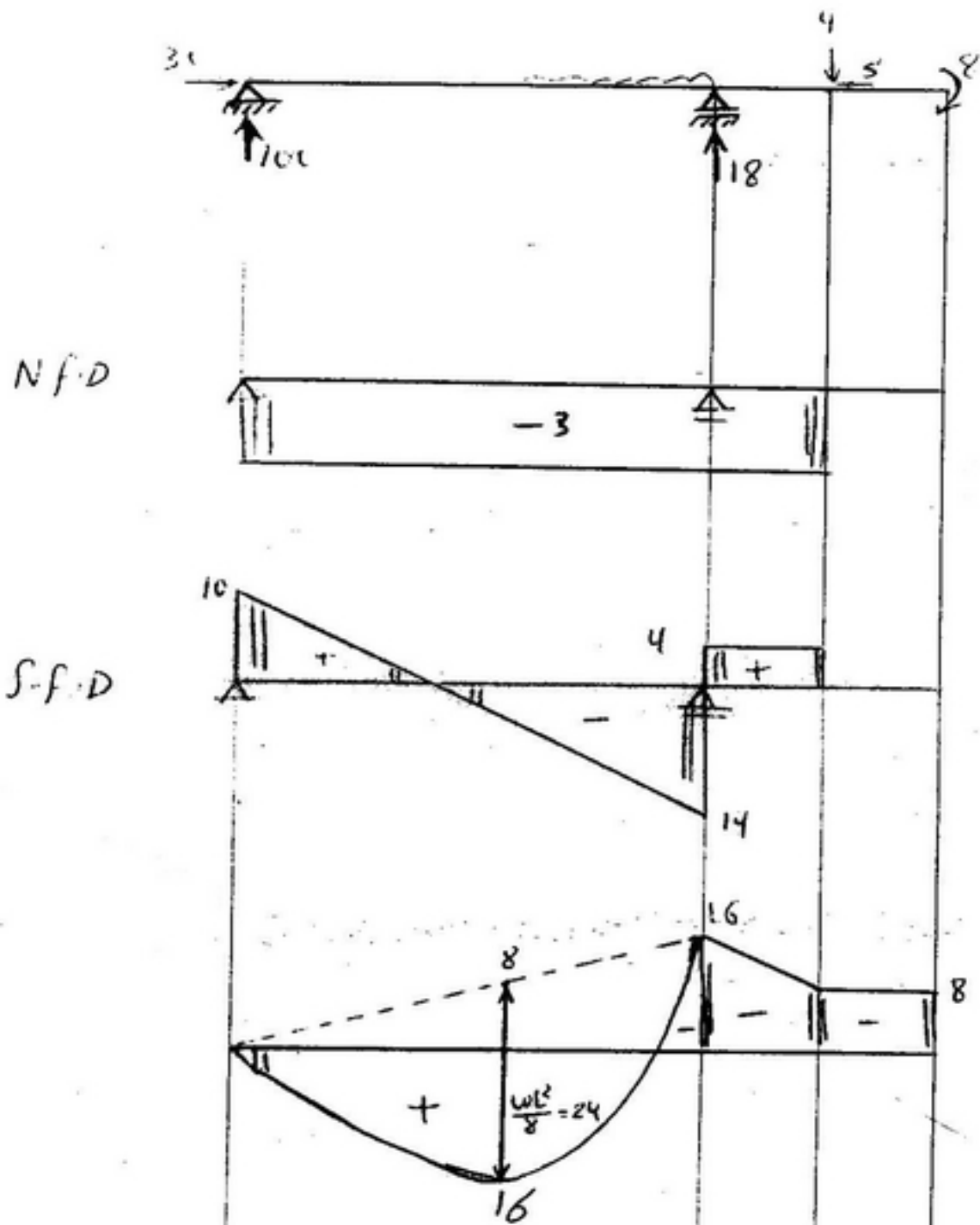
$$\Rightarrow 24 \times 4 - Y_B \times 8 + 4 \times 10 + 8 = 0$$

$$\Rightarrow Y_B = 18 \text{ t}$$

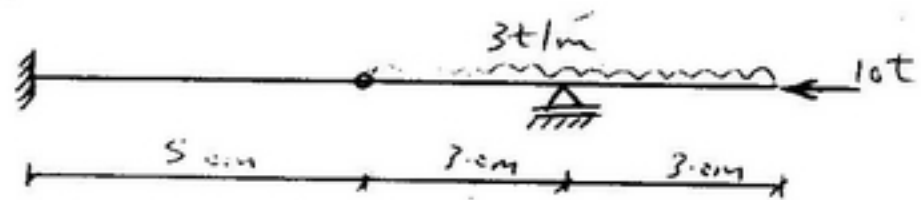
$$\sum Y = 0$$

$$\Rightarrow Y_A = 10 \text{ t}$$



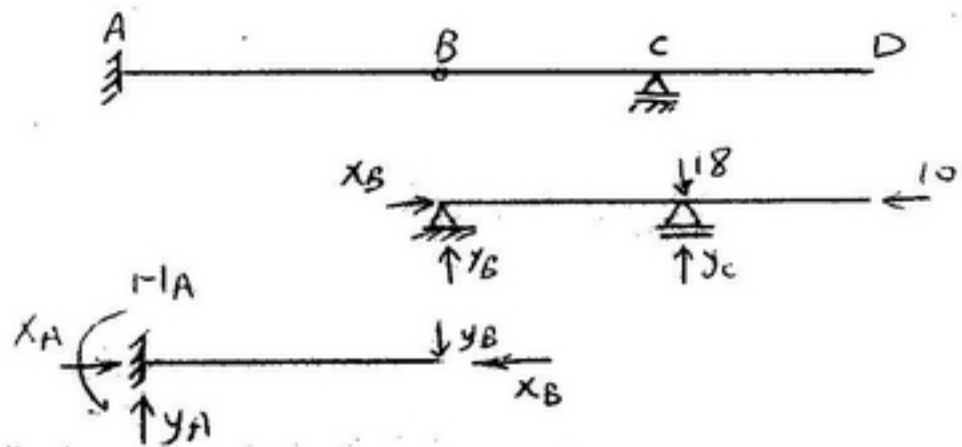


نقطة -  
الجزء +  
نقطة



draw N.f.D, S.f.D and B.M.D

— sol —



upper part

$$\sum X = 0 \Rightarrow X_B = 10t$$

$$\sum M_B = 0 \Rightarrow 18 \times 3 - Y_C \times 3 = 0 \Rightarrow Y_C = 18$$

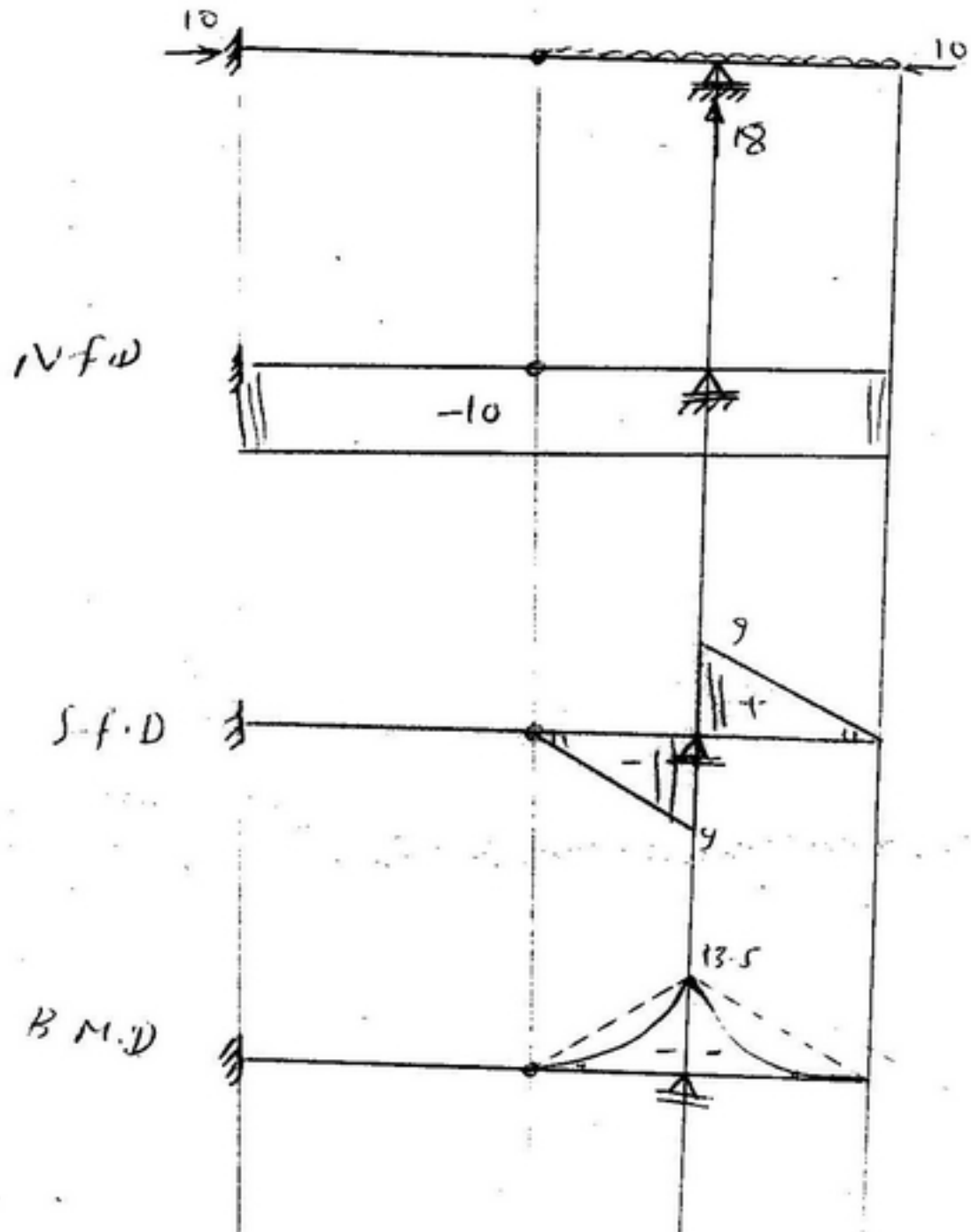
$$\sum Y = 0 \Rightarrow Y_B = 0$$

lower part

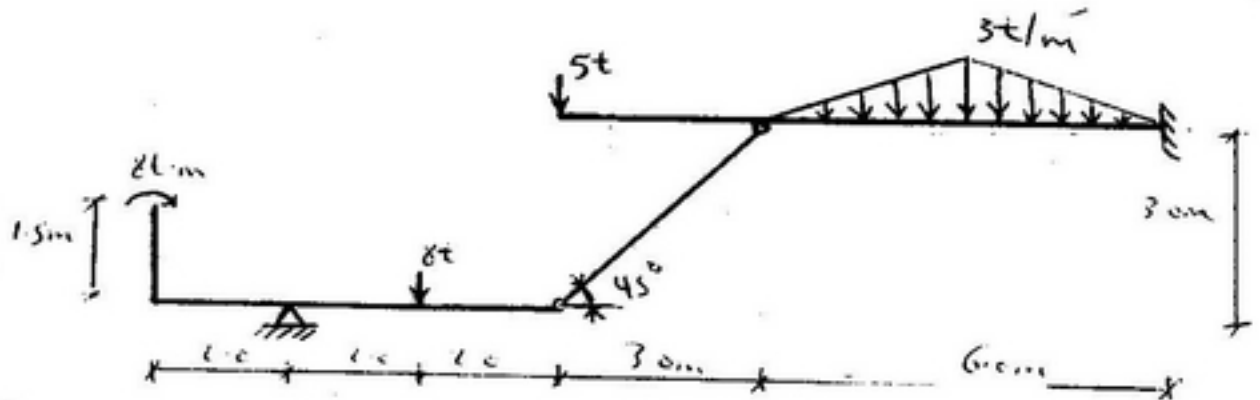
$$X_A = 10t$$

$$Y_A = 0$$

$$M_A = 0$$

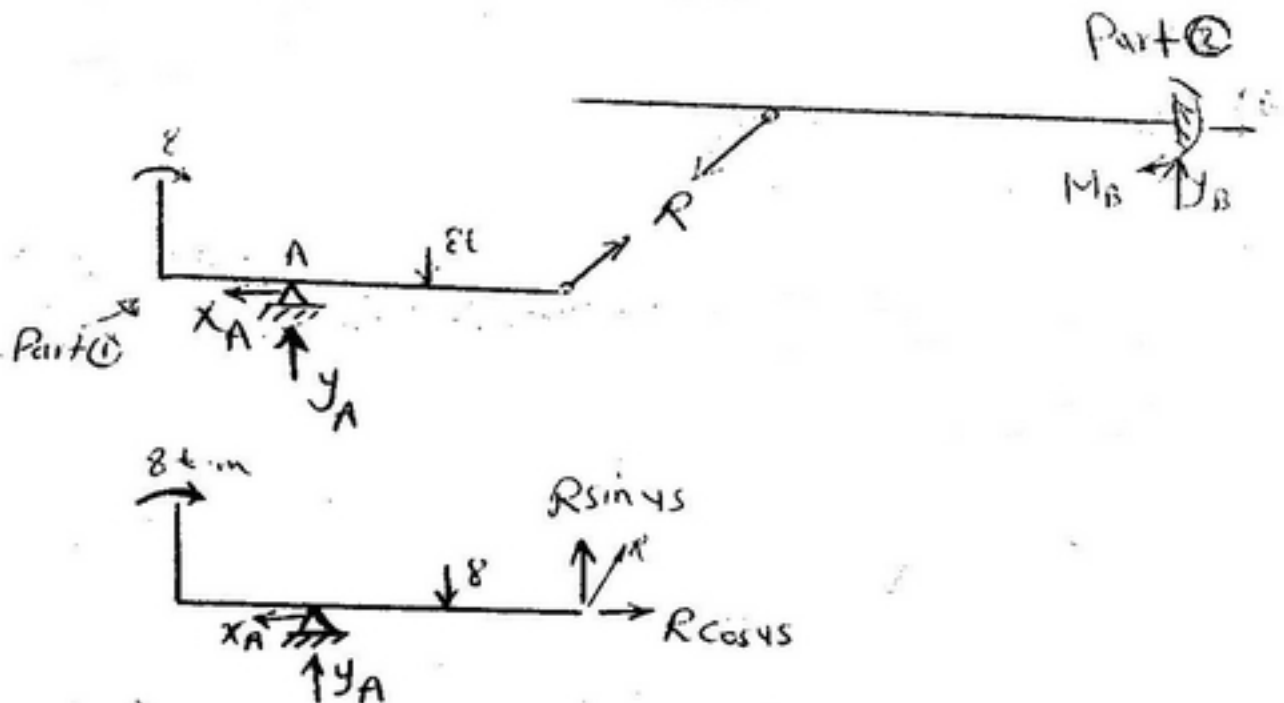


Final2002



draw N.F.D, S.F.D and B.M.D

— SOL —



$$\sum M_A = 0 \Rightarrow 8 + 8 \times 2 - R \sin 45^\circ \times 4.0 = 0.0$$

$$\therefore R = 8.5 \text{ ton}$$

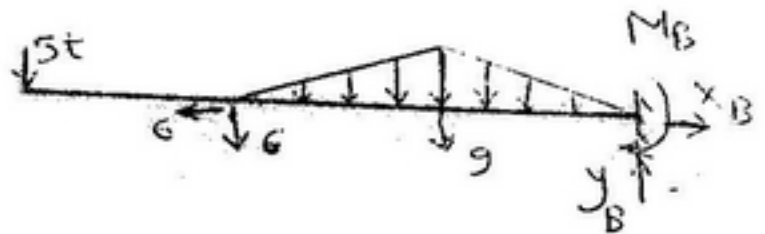
$$* \sum X = 0$$

$$\Rightarrow X_A = R \cos 45 = 6.0 \text{ ton}$$

$$* \sum Y = 0$$

$$\Rightarrow Y_A = 2 - 6 = 2 \text{ t}$$

Part ②



$$* \sum Y = 0$$

$$\Rightarrow Y_B = 20 \text{ ton}$$

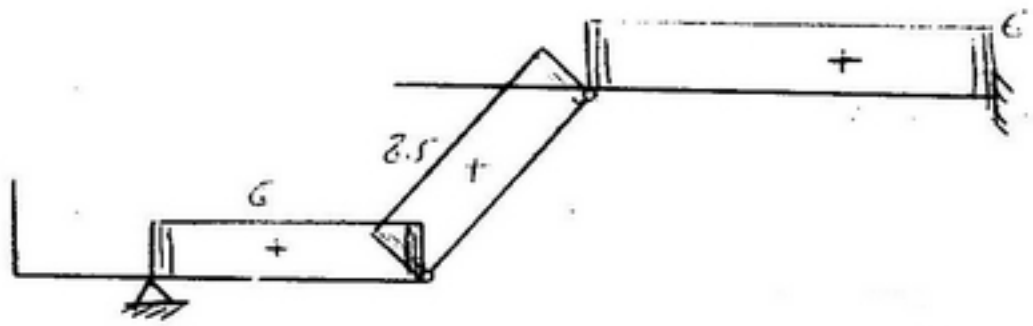
$$* \sum X = 0$$

$$\Rightarrow X_B = 6 \text{ ton}$$

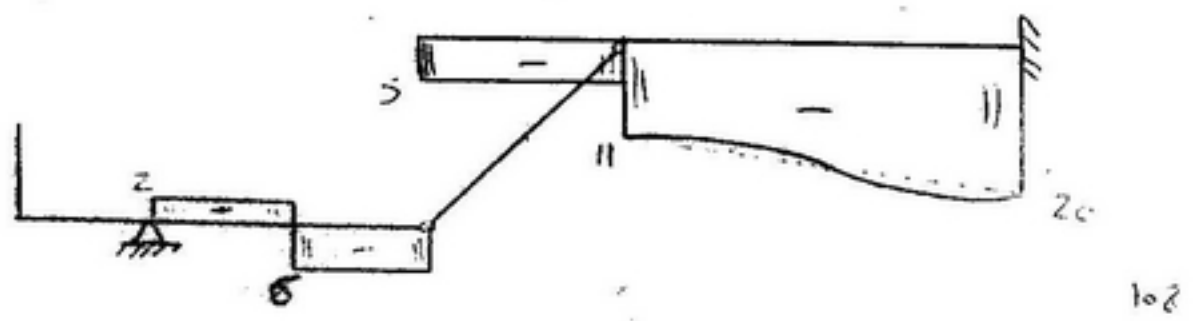
$$* \sum M = 0$$

$$\therefore M_B = 9 \times 3 + 6 \times 6 + 5 \times 9 = 108 \text{ t.m}$$

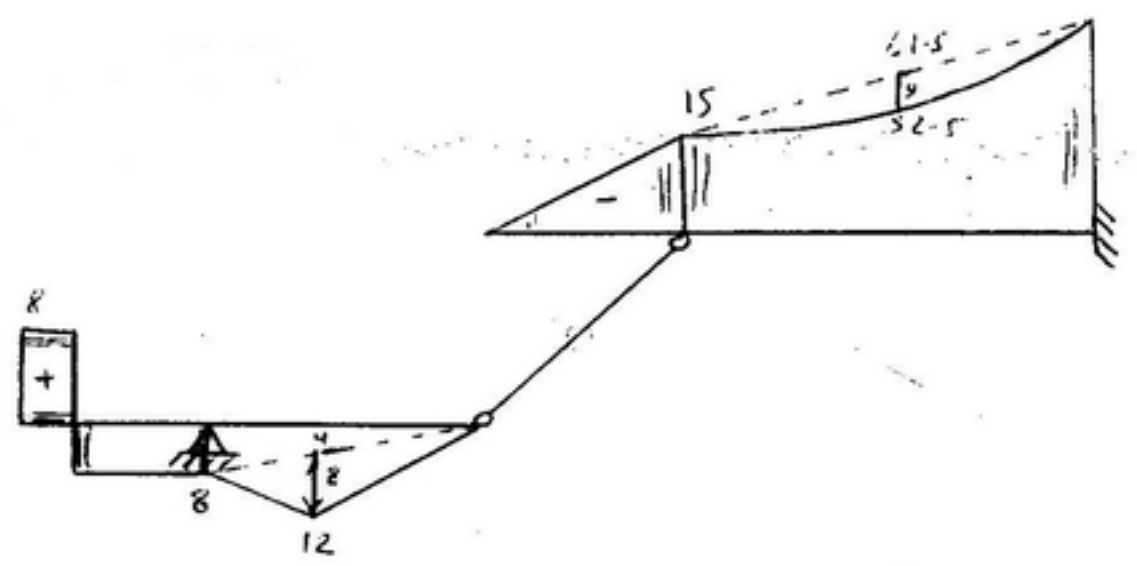
N.F.D



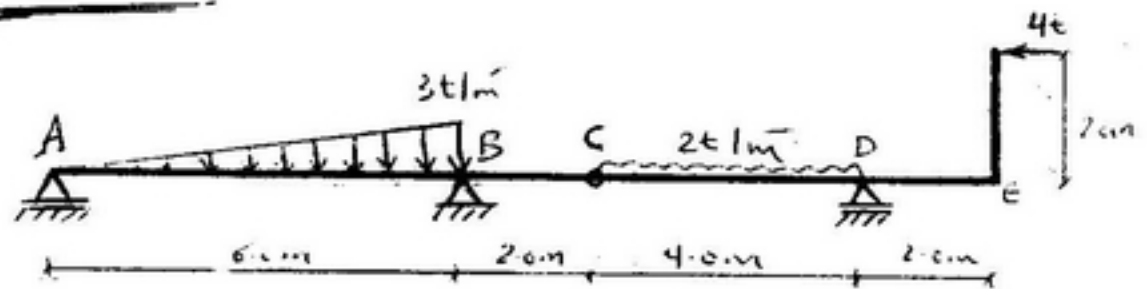
S.F.D



B.M.D

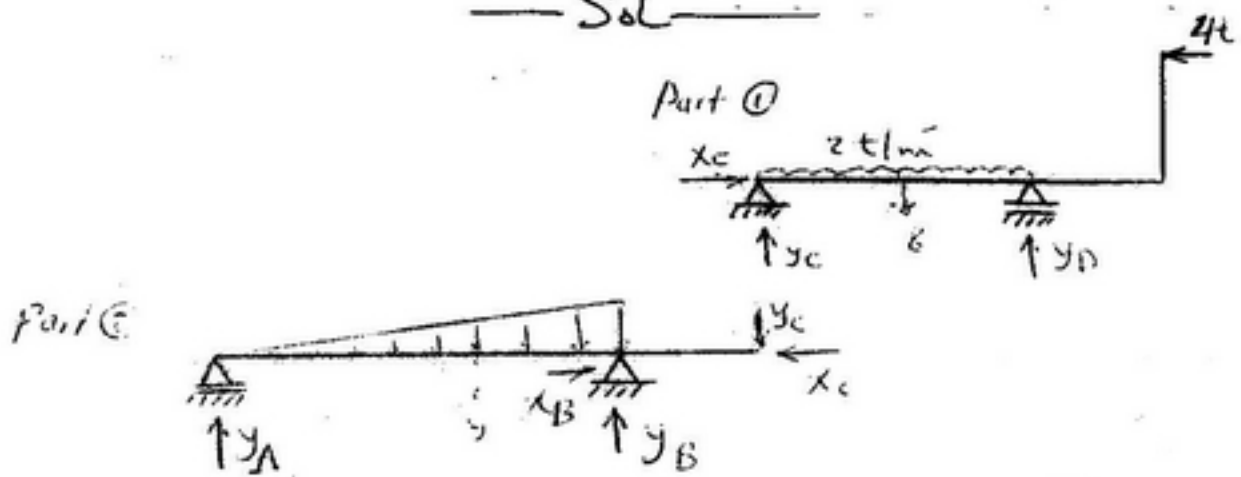


mid term 200



draw Nf.D, S.f.D and BMD

— Sol —



Part ①

$$\sum X = 0 \Rightarrow x_C = 4.0 \text{ ton}$$

$$\sum M_C = 0$$

$$2 \times 2 - 4 \times 2 = y_D \times 4 \Rightarrow y_D = 2 \text{ ton}$$

$$\sum Y = 0$$

$$\Rightarrow y_C = 6 \text{ ton}$$

part ②

$$\sum X = 0 \Rightarrow X_B = 4 \text{ ton}$$

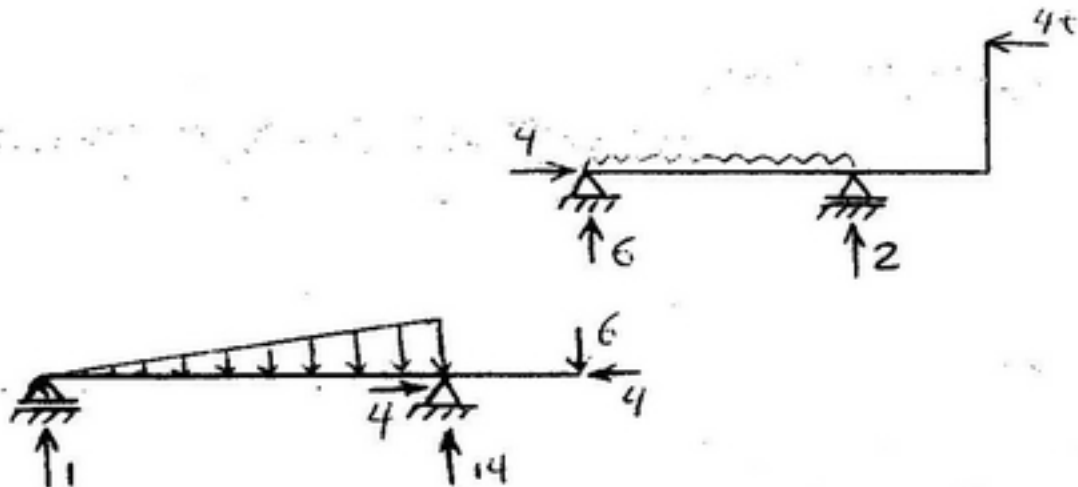
$$\sum M_A = 0$$

$$9 \times 4 + 6 \times 2 = Y_B \times 6$$

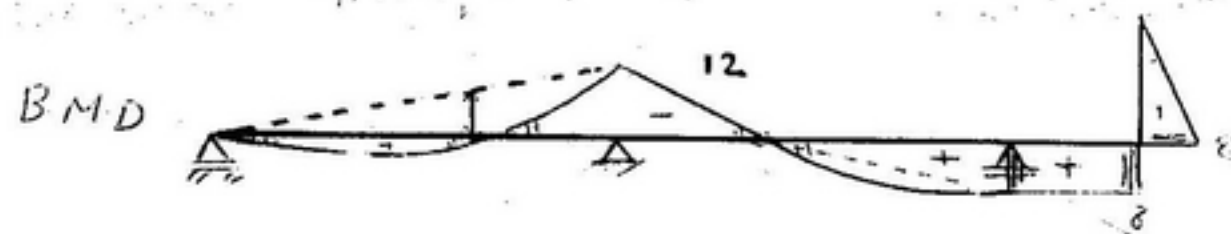
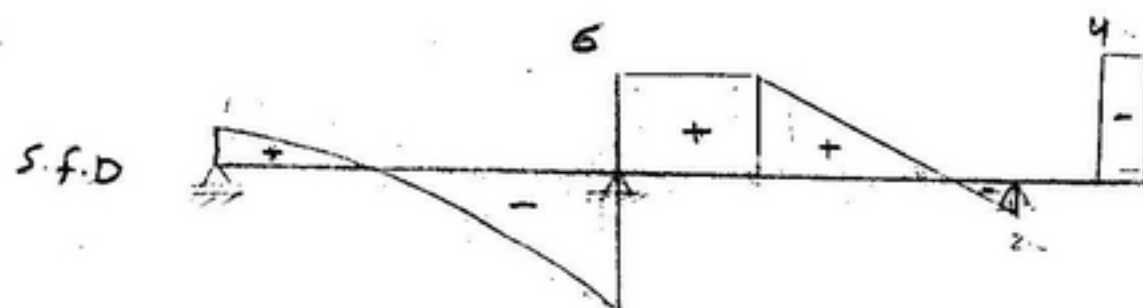
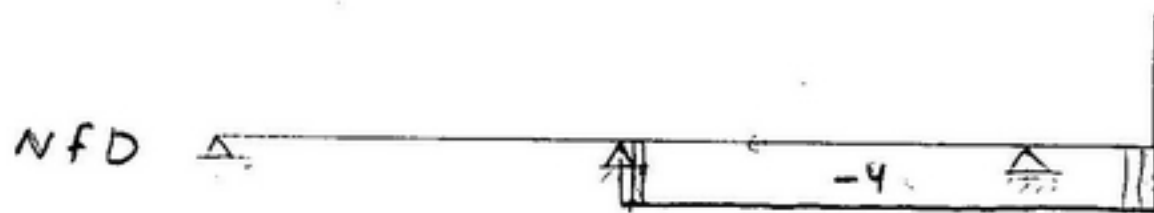
$$\therefore Y_B = 14 \text{ ton}$$

$$\sum Y = 0$$

$$\therefore Y_A = 9 + 6 - 14 = 1 \text{ ton}$$



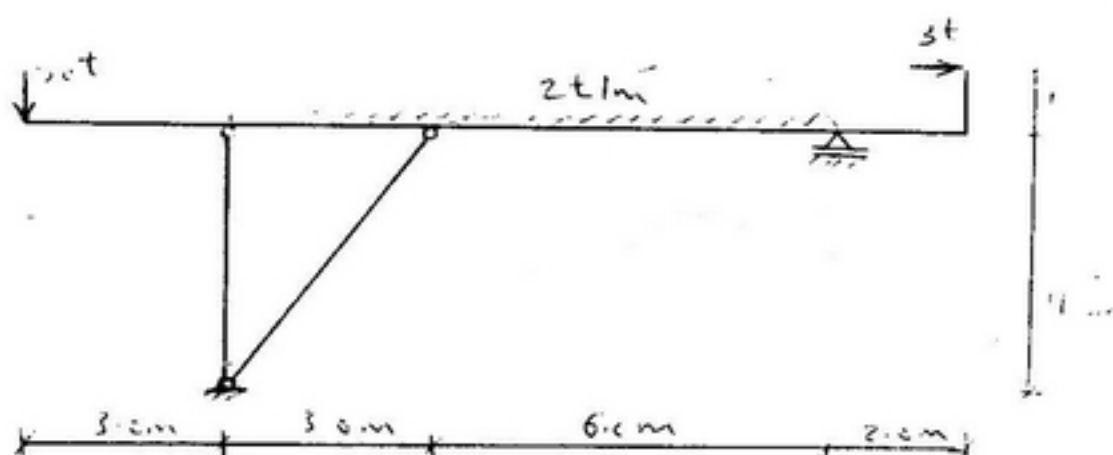




$$\frac{\sqrt{3}}{21} w l^2 = 6.93$$

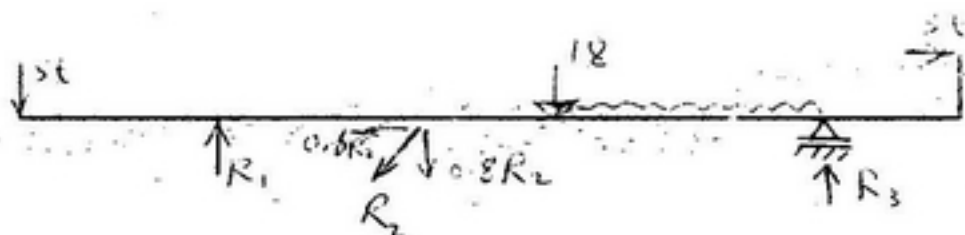
and term  
2003

22



draw N.F.D, S.F.D and B.M.D

— Sol —



$$* 0.6 * R_2 = 5$$

$$\{ R_2 = 5t \}$$

$$\therefore \sum M_i = 0$$

$$4 \times 5 + 18 \times 4.5 - 5 \times 3 + 3 \times 1 - R_3 \times 9 = 0$$

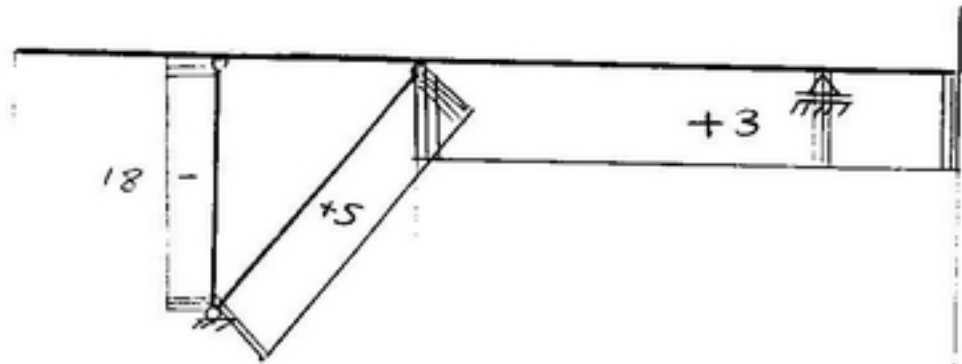
$$= R_3 = 9.0 \text{ ton}$$

$$\sum y = 0.0$$

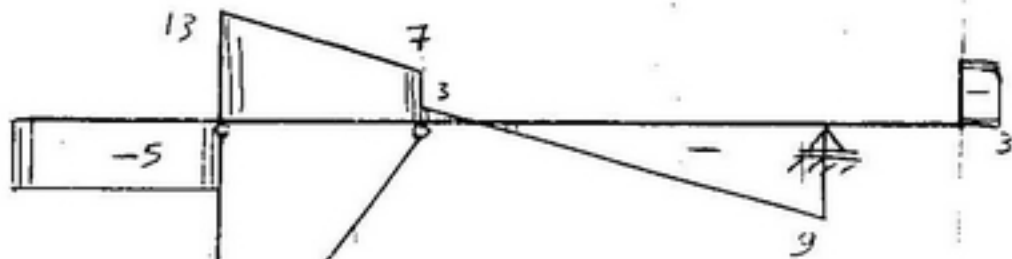
$$\Rightarrow 5 + 18 + 4 - 9 = R_1$$

$$R_1 = 18 \text{ ton}$$

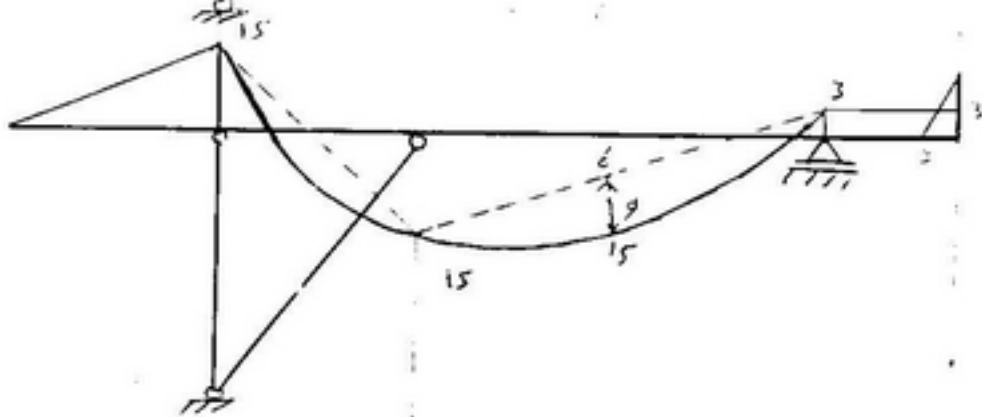
N.f.D



S.f.D



B.M.D



4.

بسم الله الرحمن الرحيم

Frame

Frame to beam

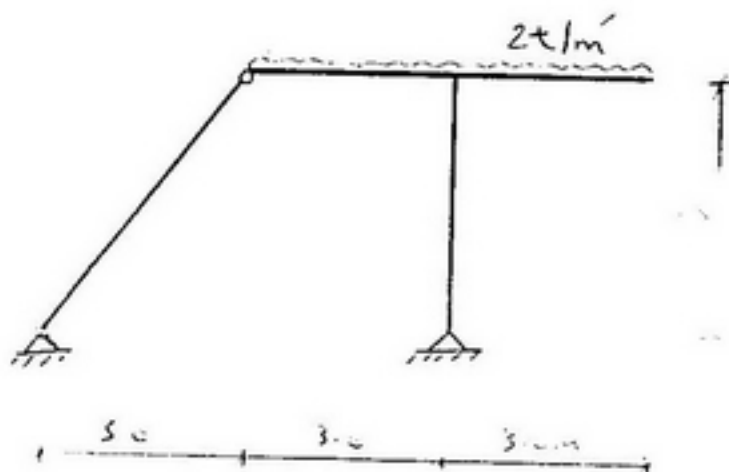
mid term 2000

For the following

Frame draw

BMD, NFD and

SFD



Sol

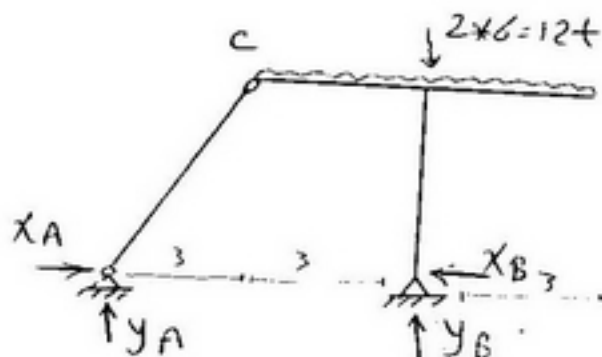
$$\sum M_A = 0$$

$$\Rightarrow 12 \times 6 = Y_B \times 8$$

$$Y_B = 12$$

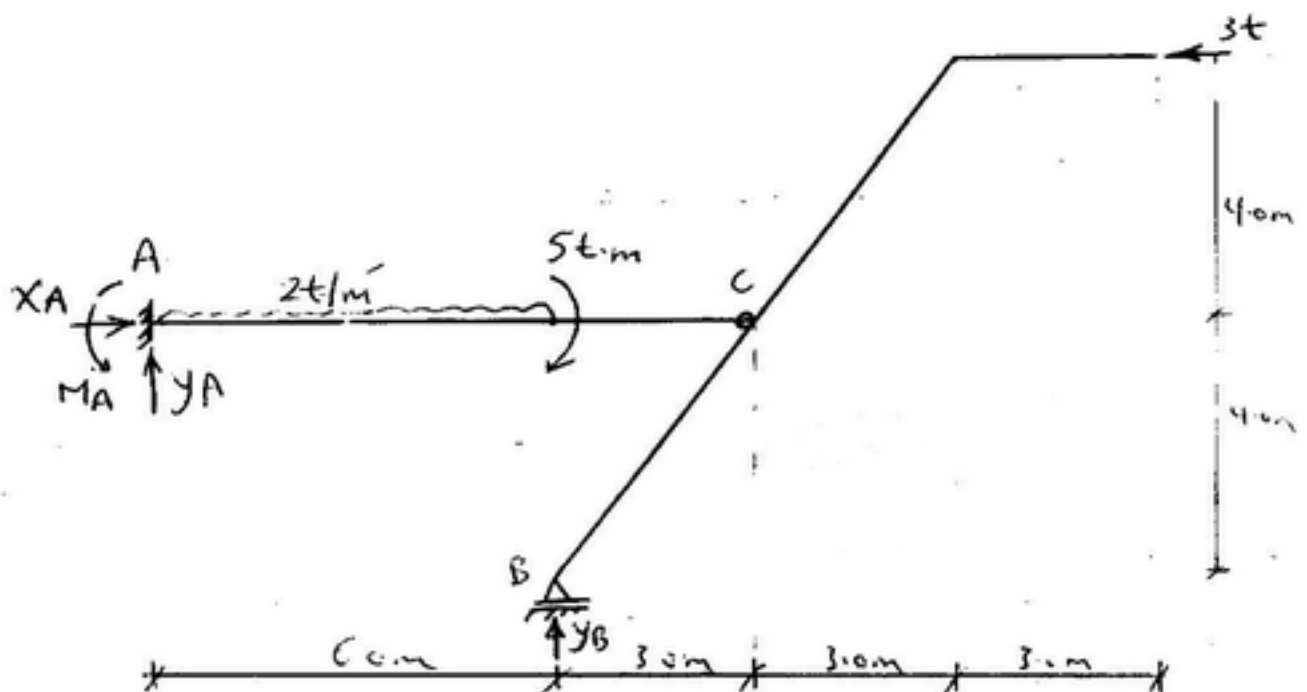
$$\sum Y = 0$$

$$\Rightarrow Y_A = 0$$





mid term 2005



- Sol -

$$\Rightarrow \sum X = 0$$

$$\Rightarrow X_H = 3.2 \text{ ton}$$

$$\Rightarrow \sum M_A = 0.0$$

$$-M_A - 2 \times 6 \times 3 + 5 - 3 \times 4 - Y_B \times 6 = 0.0$$

$$\therefore Y_B \times 6 + M_A = 29 \rightarrow (1)$$

$$\Rightarrow M_{C \text{ Right}} = 0 \Rightarrow 3 \times 4 = Y_B \times 3$$

$$\Rightarrow Y_B = 4$$

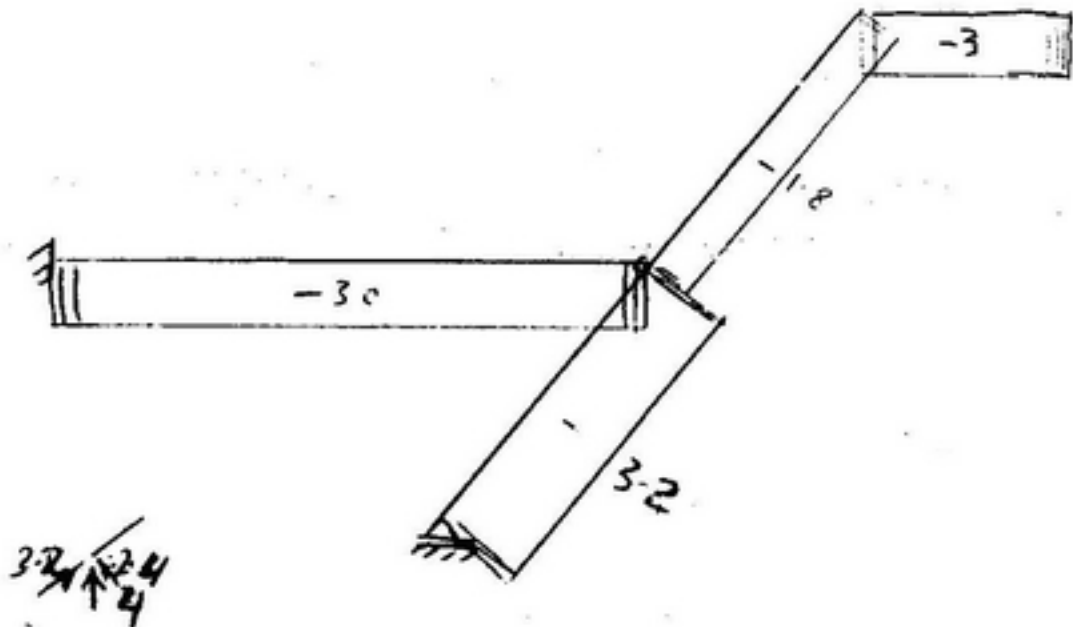
$$\circ M_A = 3 \text{ t.m}$$

$$\rightarrow \Sigma y = 0$$

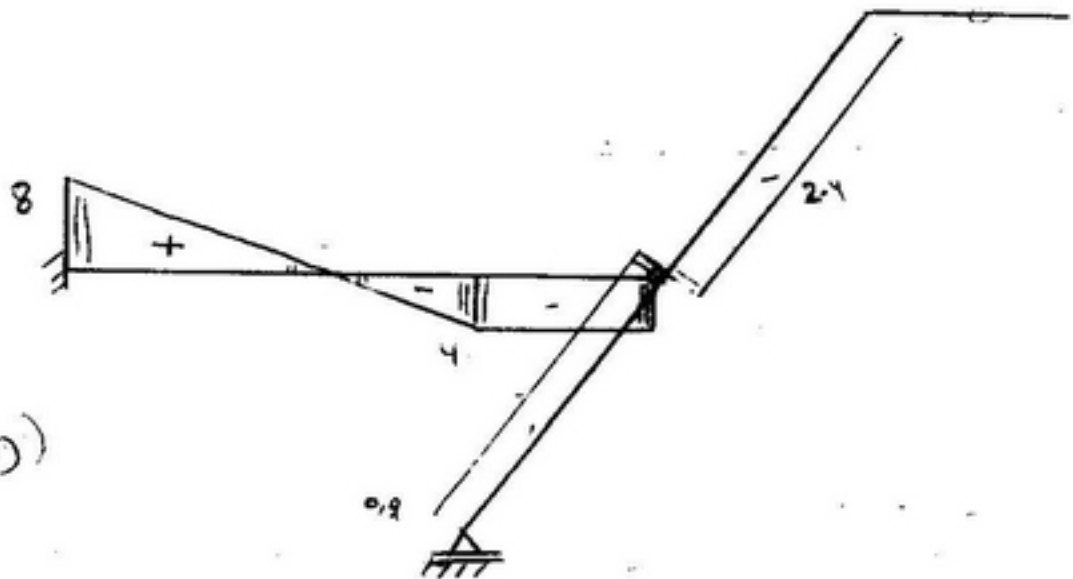
$$\rightarrow y_A = 12 - 4.0 = 8 \text{ t.m.}$$

$$\begin{aligned} 3 \times 6 &= 1.8 \\ 3 \times 8 &= 2.4 \end{aligned}$$

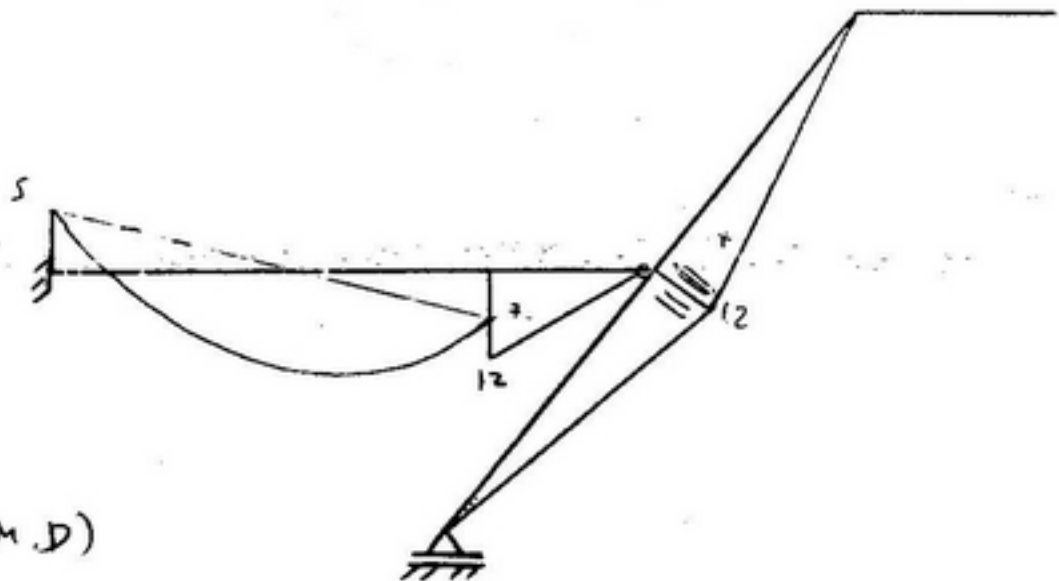
(N.F.D)



(S.f.D)

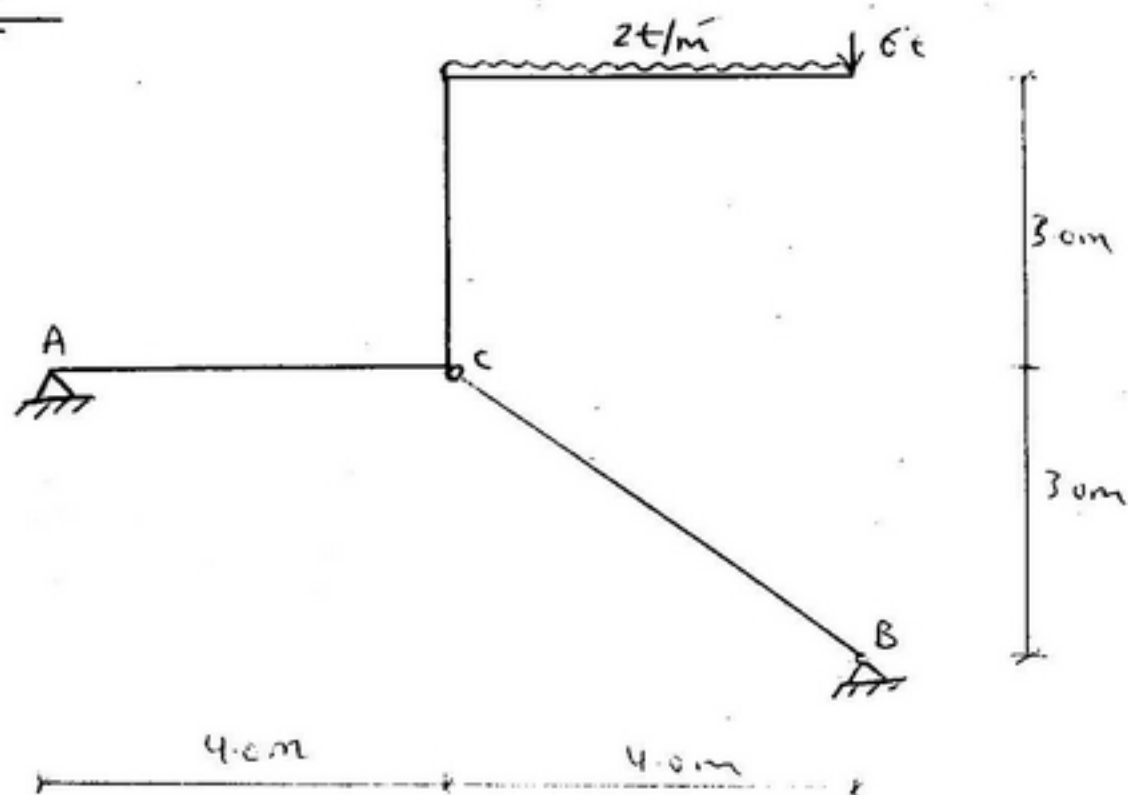


(B.M.D)





Final 2001



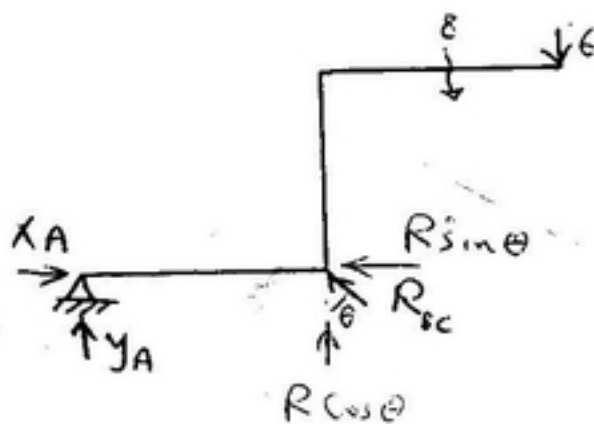
— Sol —

$$\sum M_C = 0$$

$$\Rightarrow y_A \times 4 + 6 \times 4 + 8 \times 2 = 0$$

$$y_A = -10$$

$$y_A \downarrow$$



6

$$\star \sum Y = 0$$

$$10 + 6 + 8 = R \cos \theta$$

$$24 = R \times 0.6$$

$$\therefore R = 40 \text{ ton}$$

$$\cos \theta = 0.6$$

$$\sin \theta = 0.8$$

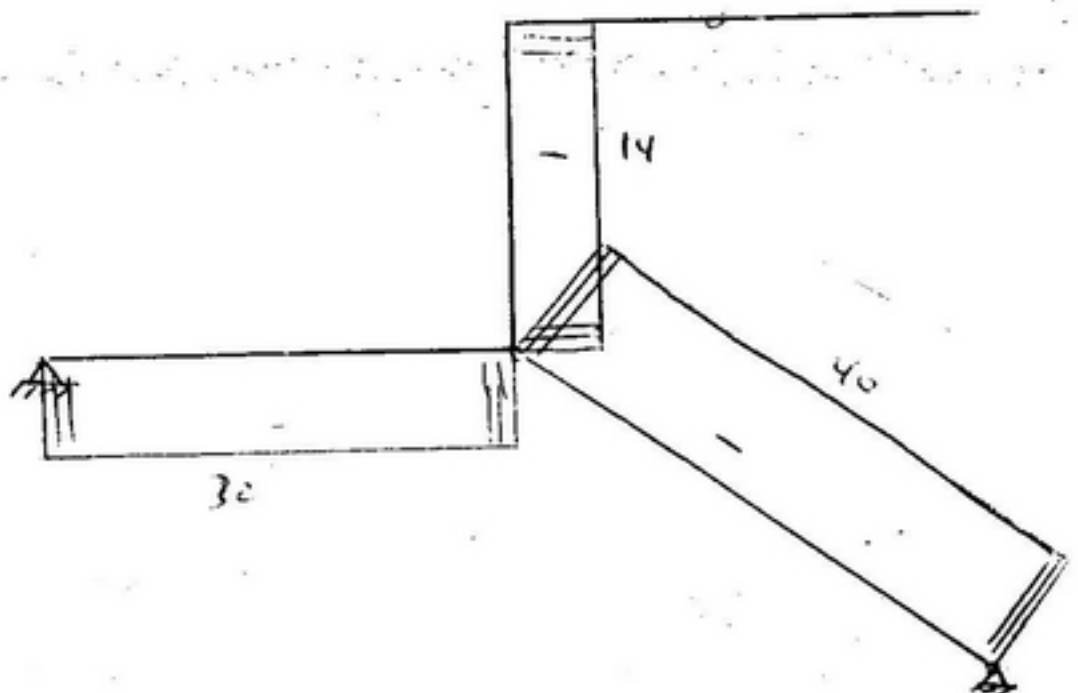


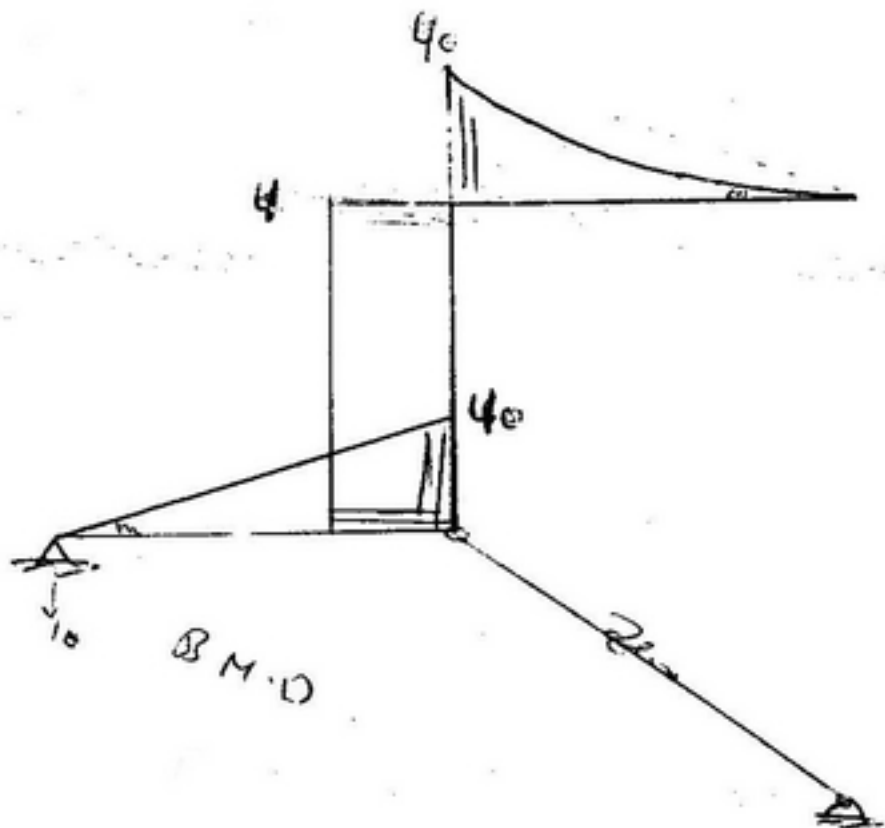
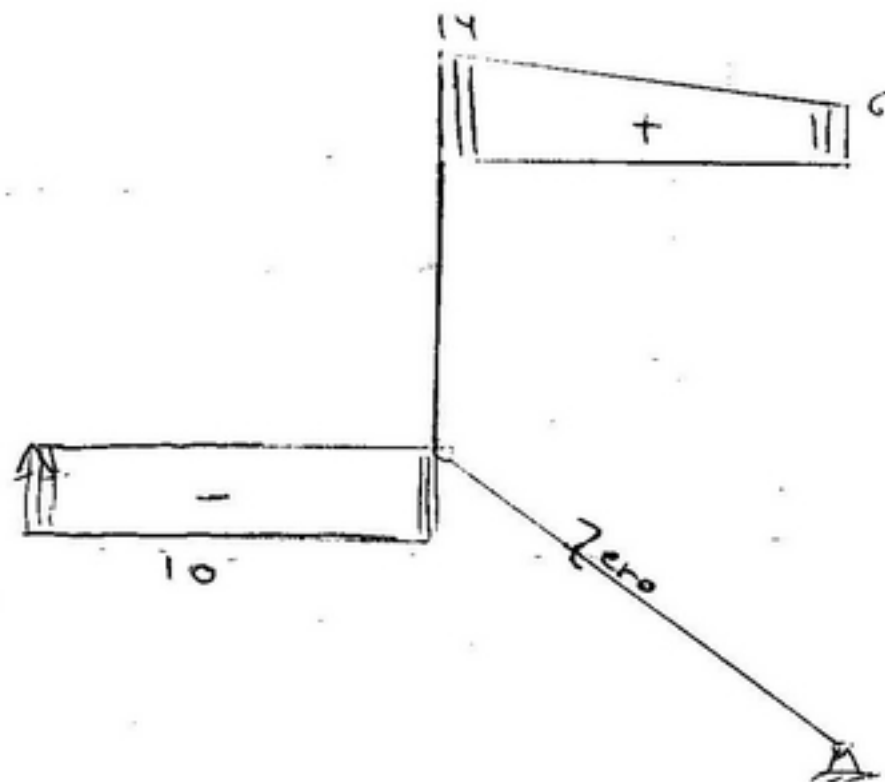
$$\star \sum X = 0$$

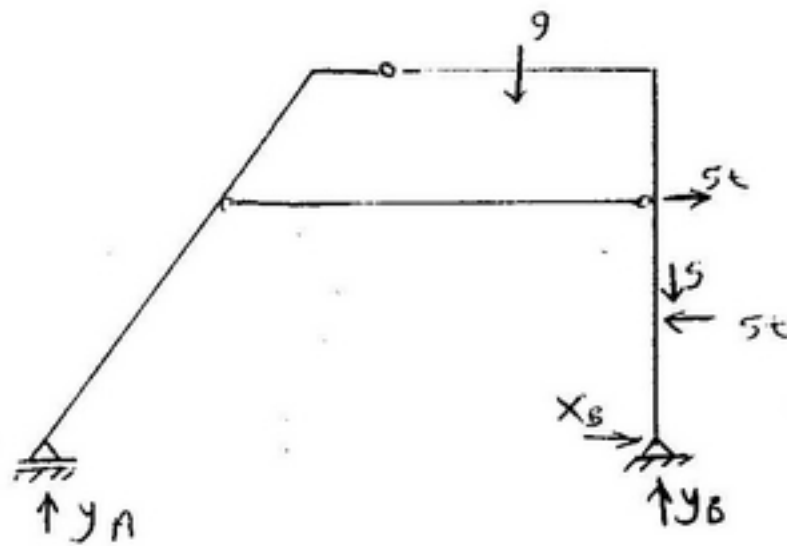
$$R \times 0.8 = X_A$$

$$X_A = 32 \text{ ton}$$

N.F.D







$$\sum X = 0.0$$

$$\Rightarrow X_B = 0.0$$

$$\sum M_A = 0.0$$

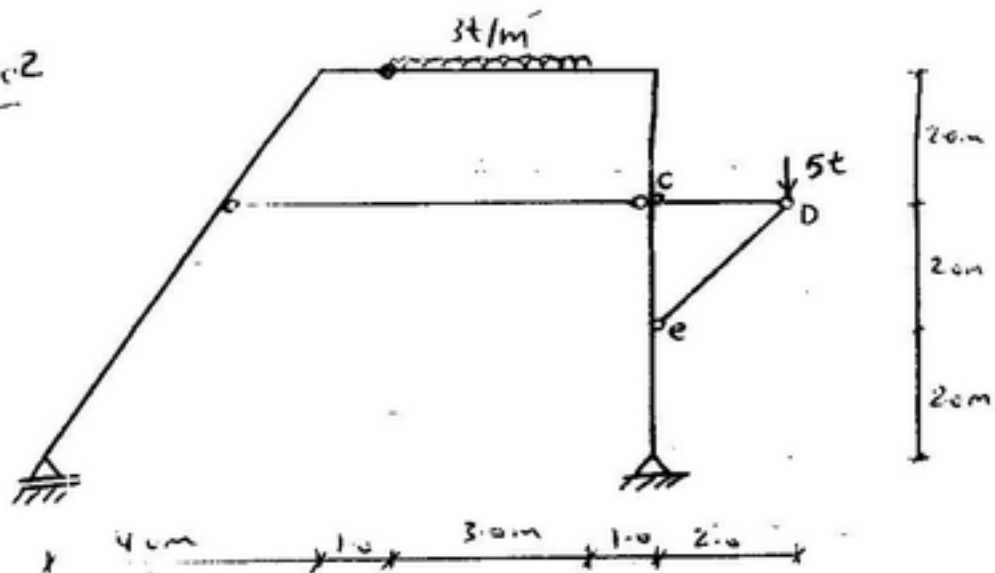
$$5 \times 9 + 9 \times 6.5 + 5 \times 4 - 5 \times 2 = Y_B \times 9$$

$$\therefore Y_B = 12.611 \text{ ton}$$

$$\sum Y = 0.0$$

$$Y_A = 1.389 \text{ ton}$$

Final 2002



- SCL -

$$\sum M_{D/L} = 0.0$$

$$y_c \times 2 = 0.0$$

$$\Rightarrow y_c = 0.0$$

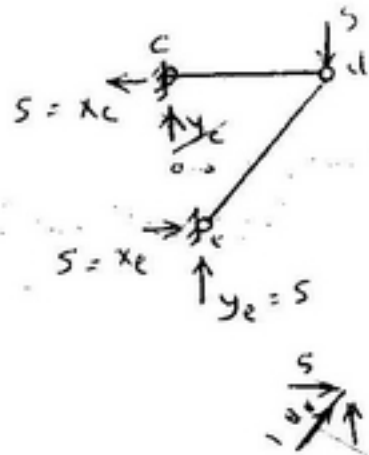
$$\therefore \sum y = 0.0$$

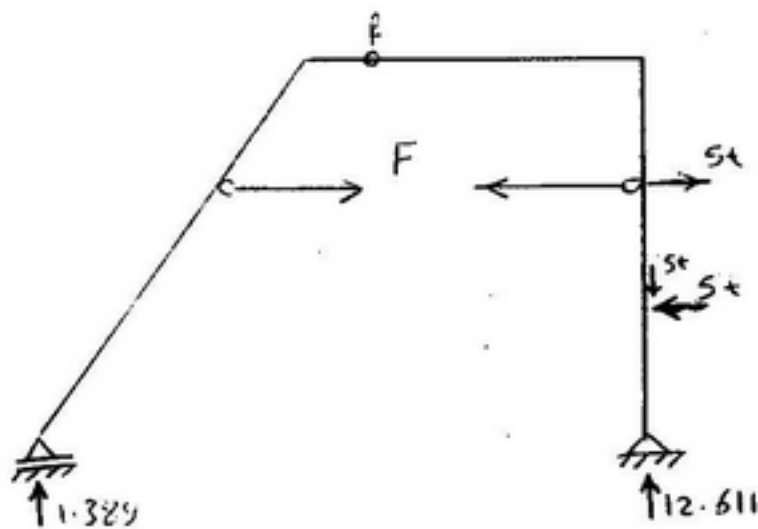
$$\Rightarrow y_e = 5t$$

$$\sum M_e = 0.0$$

$$x_e \times 2 = 5x \cdot \frac{1}{2} \Rightarrow x_c = 5t$$

$$\Rightarrow x_e = 5t$$

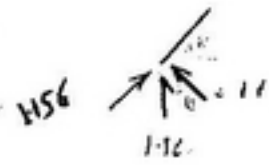




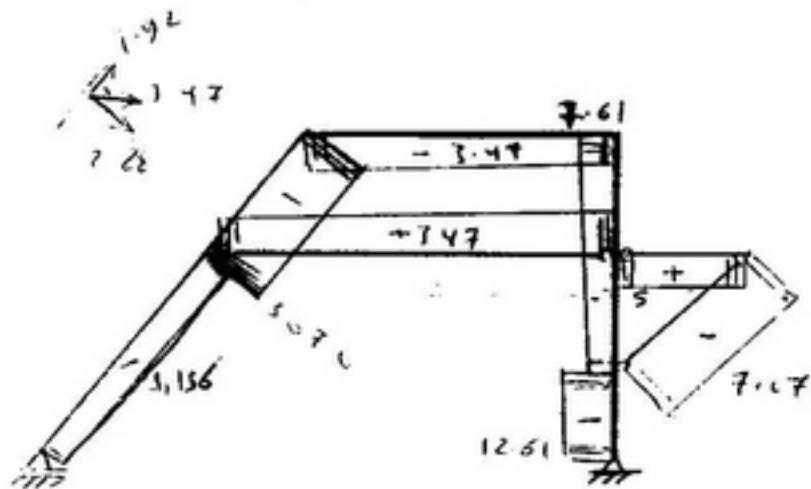
$$\sum M_{\text{left}} = 0.0$$

$$F \times 2 = 1.329 \times 5$$

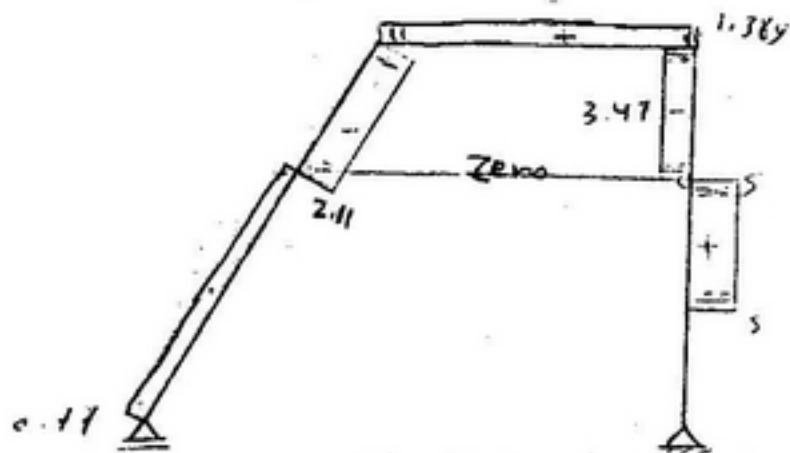
$$\Rightarrow F = 3.47 \text{ kN}$$



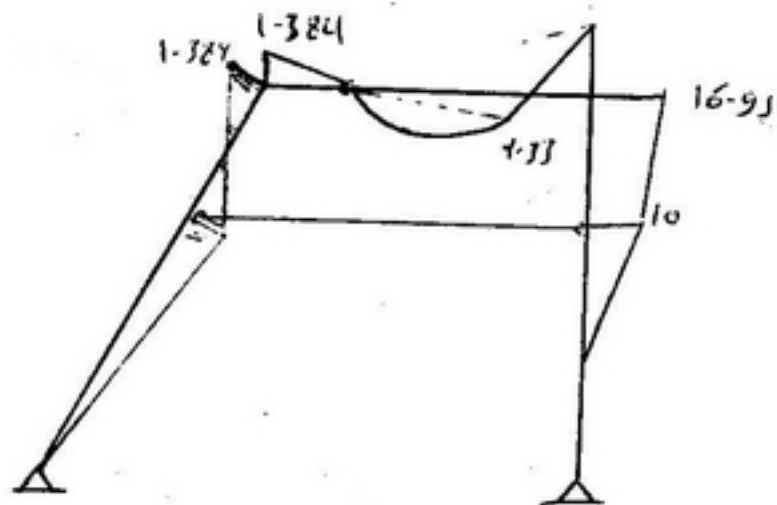
N.F.D



S.F.D

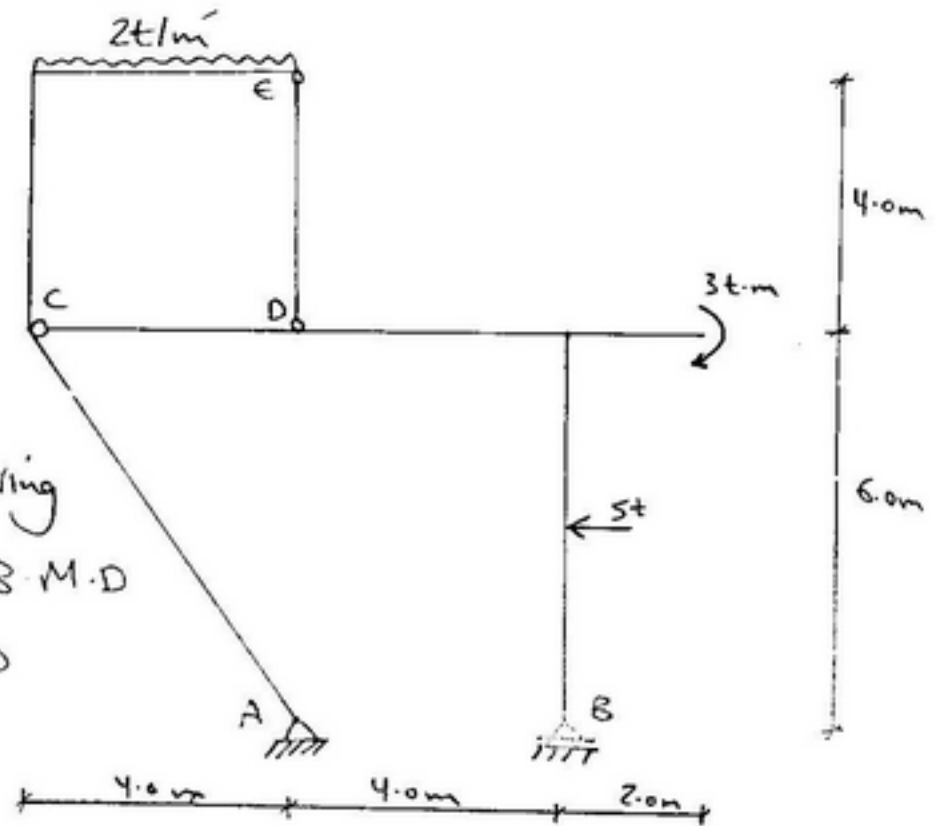


B.M.D

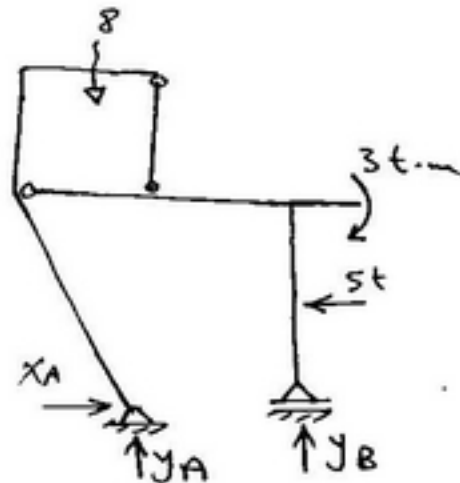


Final 2004

For the Following  
Frame draw B.M.D  
S.F.D, N.F.D



— Sol. —





For Reactions

$$\Rightarrow \sum X = \dots$$

$$X_A = 5.0 \text{ ton}$$

$$\Rightarrow \sum M_A = \dots$$

$$-8 \times 2 + 3 - 5 \times 3 - Y_B \times 4 = \dots$$

$$Y_B = -7 \Rightarrow Y_B = \downarrow 7 \text{ ton}$$

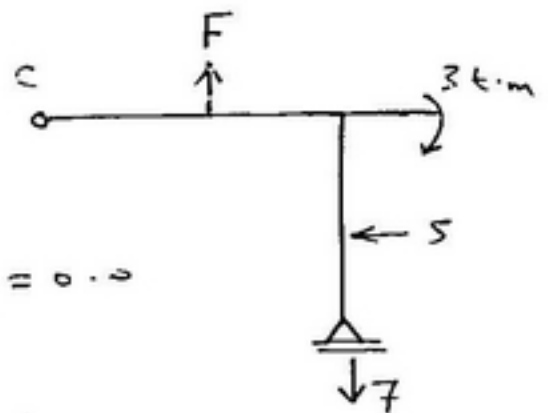
$$\Rightarrow \sum Y = \dots$$

$$Y_A = 7 + 8 = 15 \text{ ton}$$

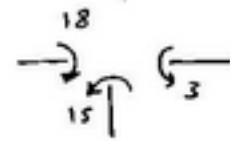
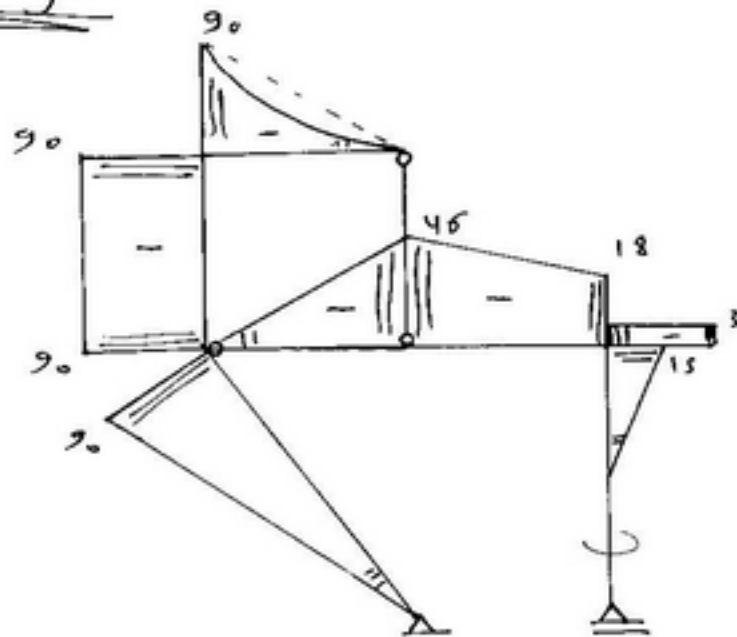
$$\times \sum M_{C_R} = \dots$$

$$-5 \times 3 + F \times 4 - 3 - 7 \times 8 = \dots$$

$$\Rightarrow F = 18.5 \text{ ton}$$

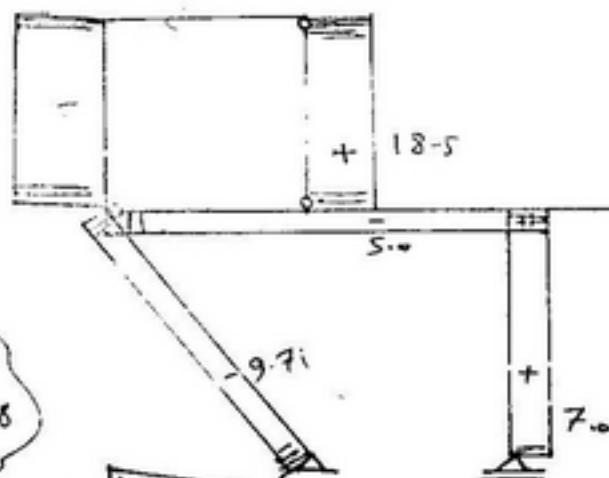


drawings



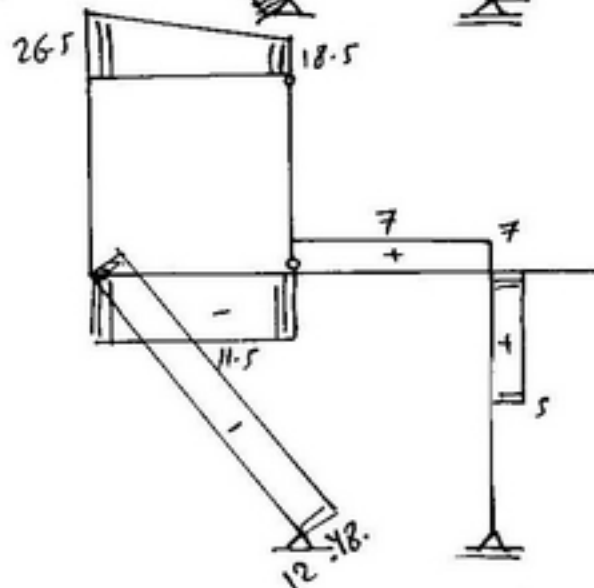
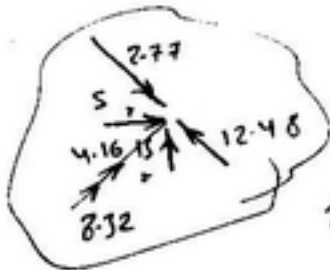
B.M.D

26.5

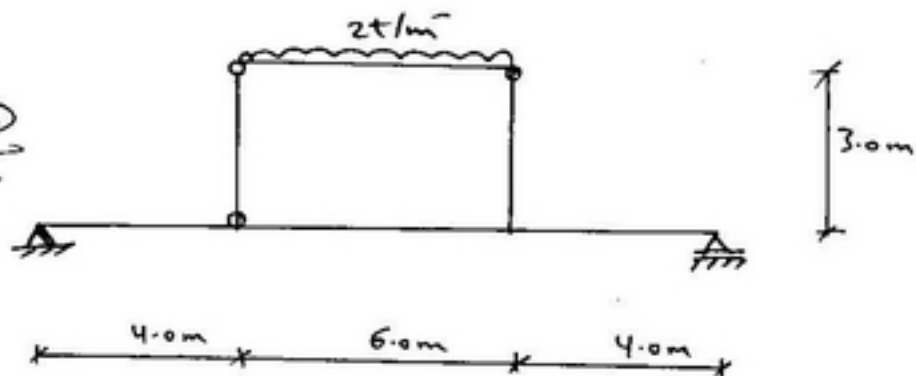


N.f.D

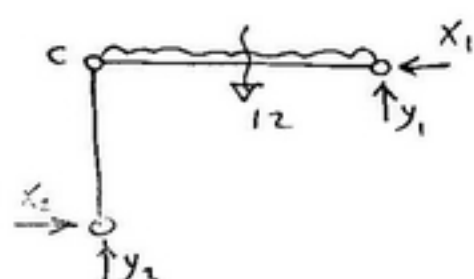
12.48  
→ 9.71



draw  
B.M.D, N.F.D



———— Sol ———



$$\sum M_{C_d} = 0 \dots$$

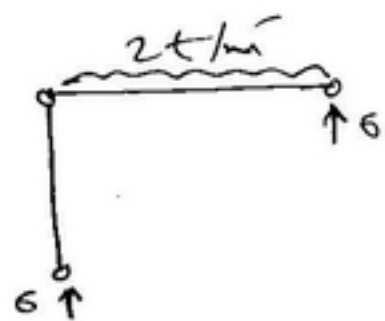
$$X_2 = 0 \dots$$

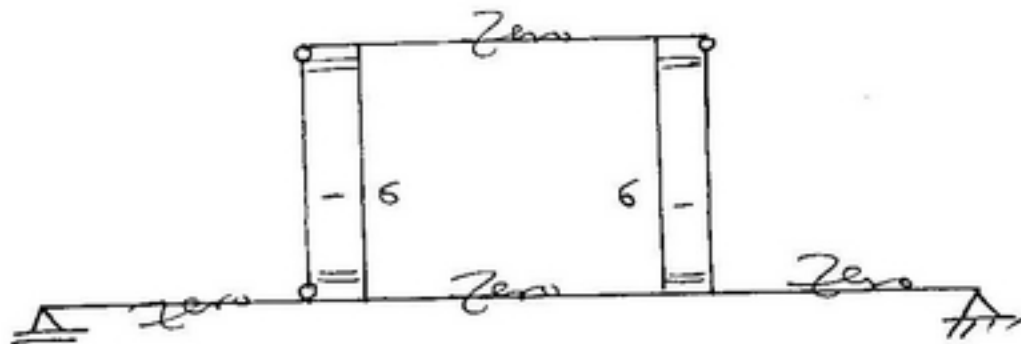
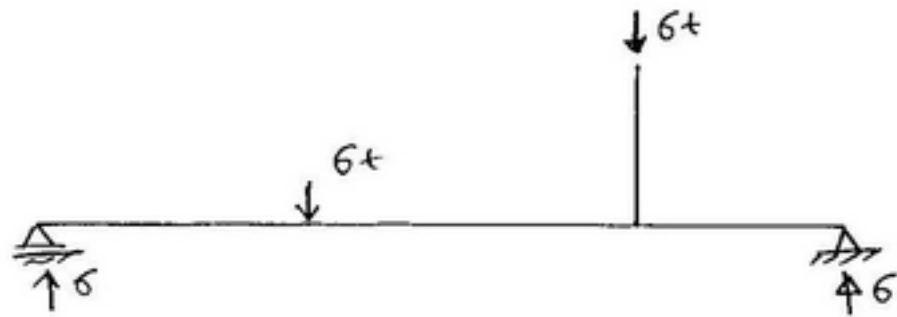
$$\sum X = 0 \dots$$

$$X_1 = 0 \dots$$

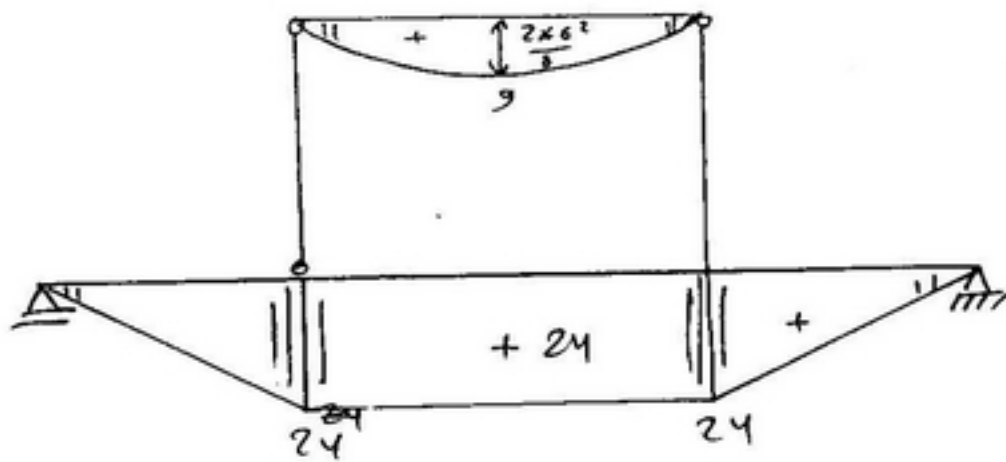
$$\sum M_2 = 0 \dots$$

$$\Rightarrow y_1 = \frac{12}{2} = 6.0 \text{ ton} = y_2$$





N.F.D



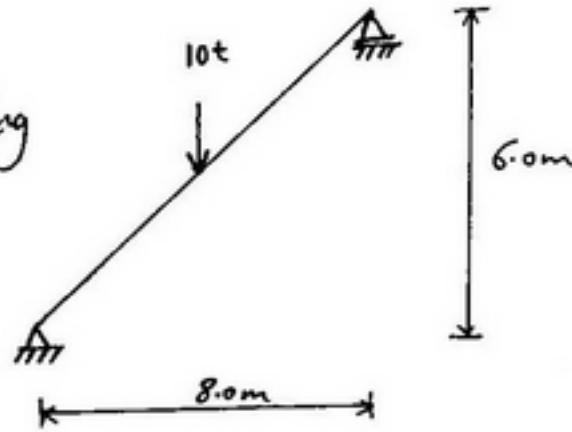
B.M.D

5

الامرات 4 لله  
1, 2, 3

## Example

For the following  
beam  
draw  
B.M, N.F, S.F

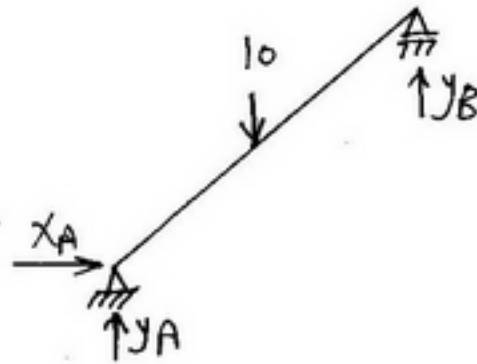


— Sol —

## For Reactions

$$\ast \sum X = 0$$

$$X_A = 0$$

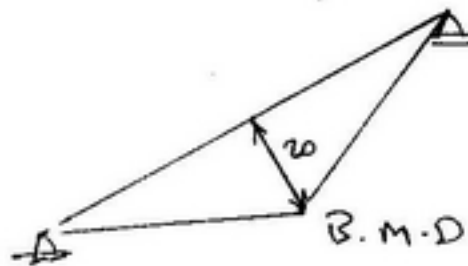
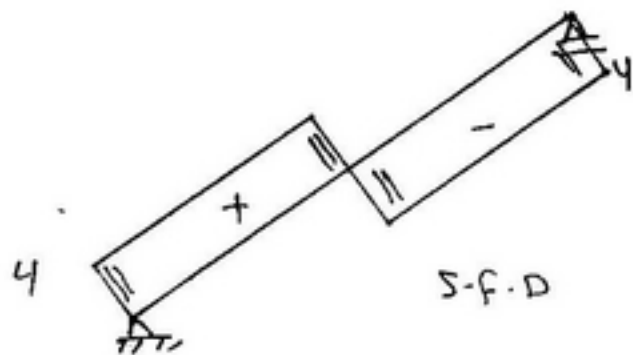
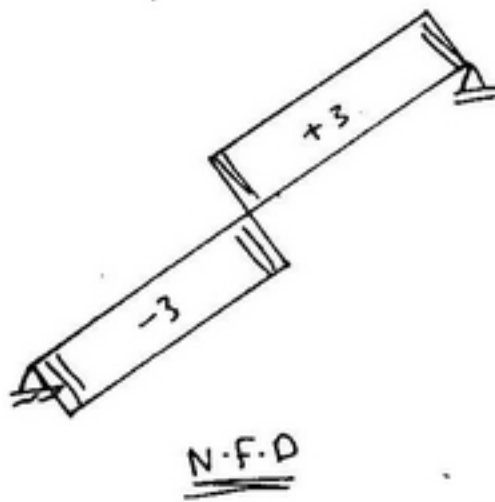
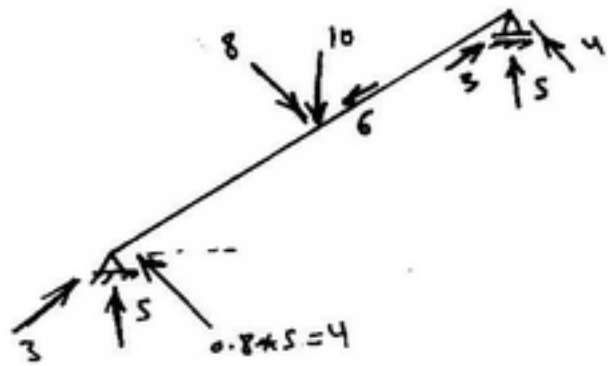


$$\ast \sum M_A = 0$$

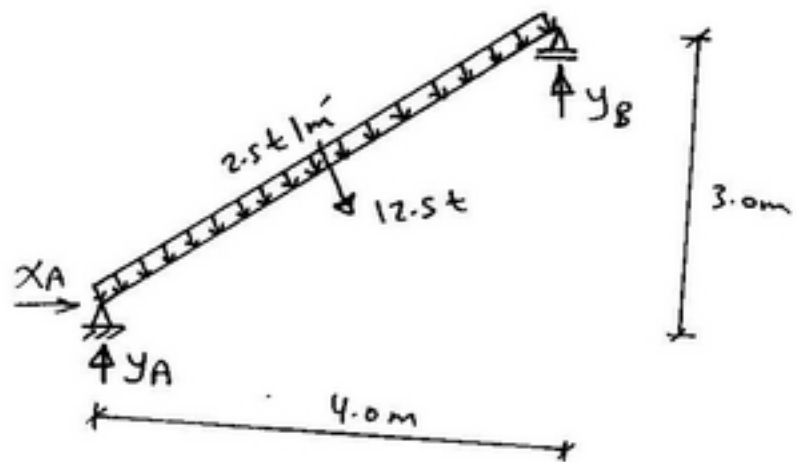
$$10 \times 4 - Y_B \times 8 = 0$$

$$\Rightarrow Y_B = 10/2 = 5 \text{ t}$$

$$\therefore \sum Y = 0 \Rightarrow Y_A = 5 \text{ t}$$



### Example ②



— Sol —

#### Reactions

$$\sum X = 0.0$$

$$\Rightarrow X_A = -7.5 \text{ ton}$$

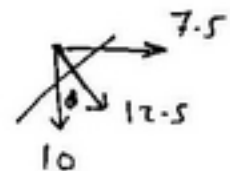
$$\sum M_A = 0.0$$

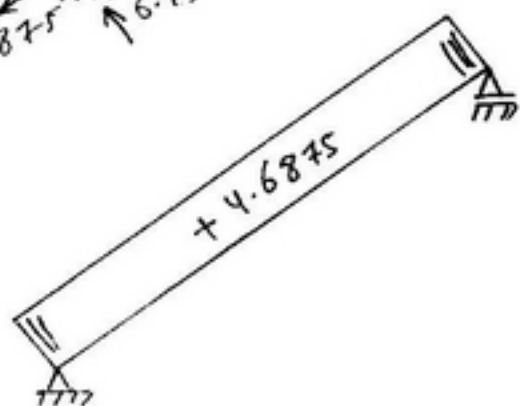
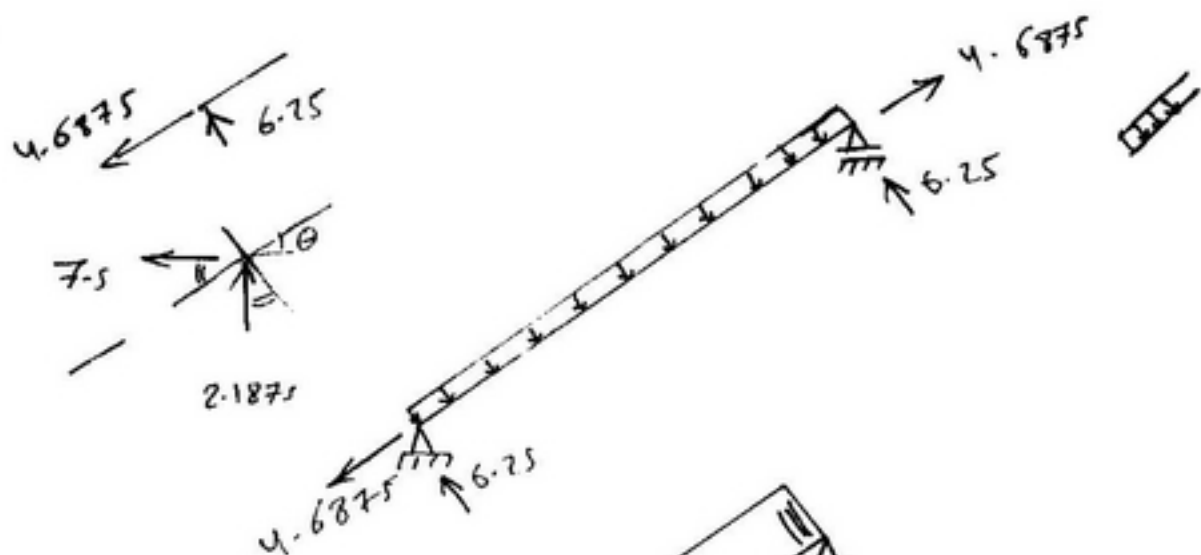
$$\Rightarrow 12.5 \times 2.5 - Y_B \times 4 = 0.0$$

$$\Rightarrow Y_B = 7.8125 \text{ ton}$$

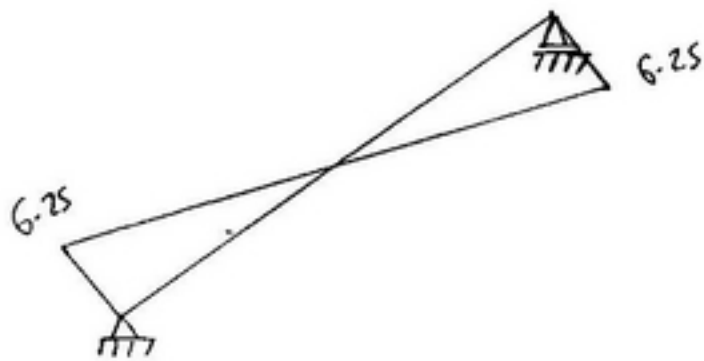
$$\sum Y = 0.0$$

$$\begin{aligned} \Rightarrow Y_A &= 10 - 7.8125 \\ &= 2.1875 \text{ ton} \end{aligned}$$

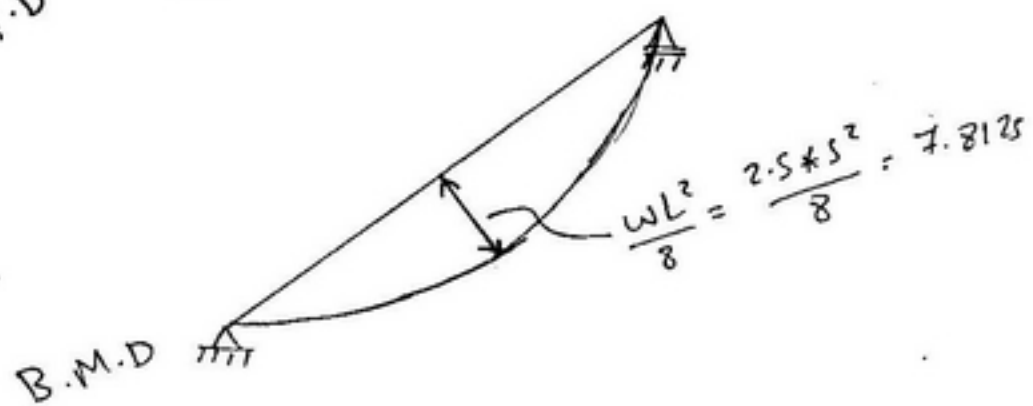




N.F.D



S.F.D

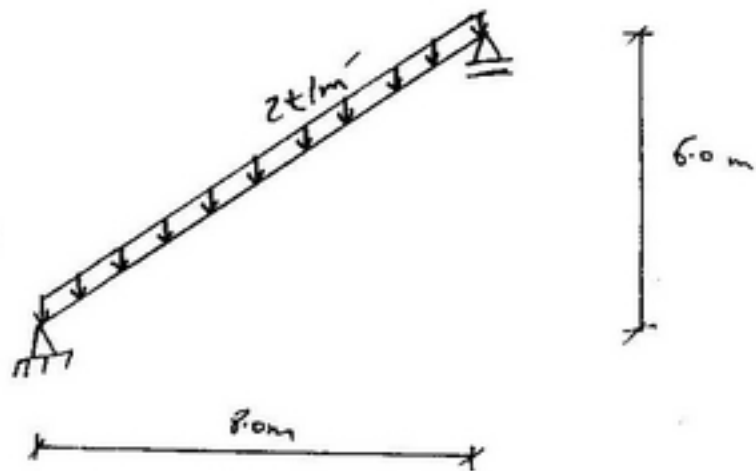


B.M.D

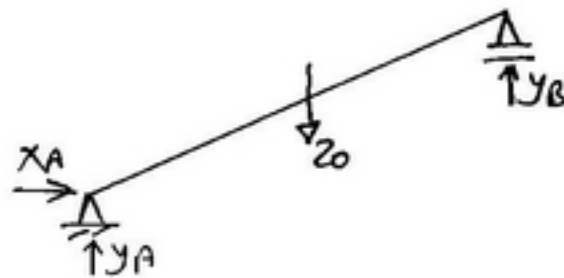


## Example

draw B.M.D  
N.F.D, S.F.D



— Sol —



$$\sum X = 0$$

$$\Rightarrow X_A = 0$$

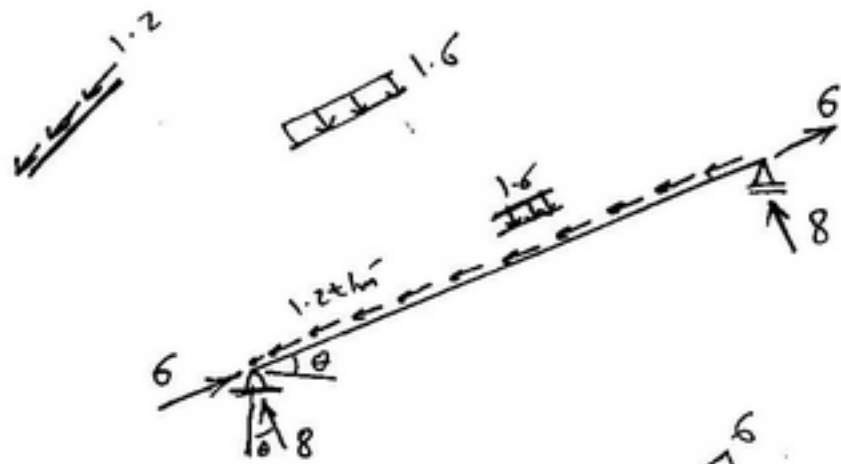
$$\sum M_A = 0$$

$$\Rightarrow 20 \times 4 - Y_B \times 8 = 0$$

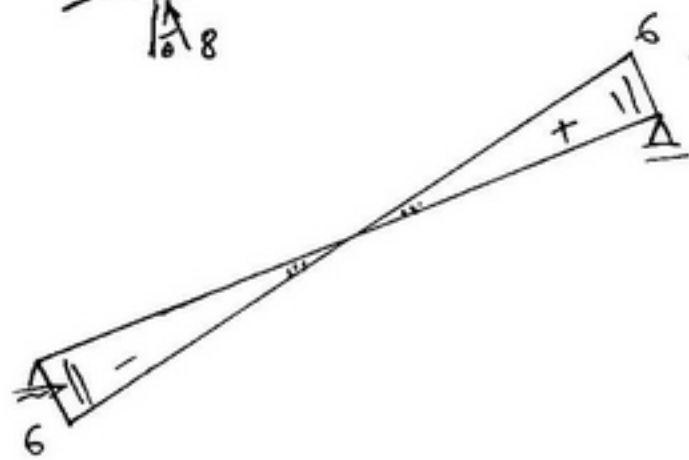
$$\Rightarrow Y_B = 10 \text{ ton}$$

$$\sum Y = 0$$

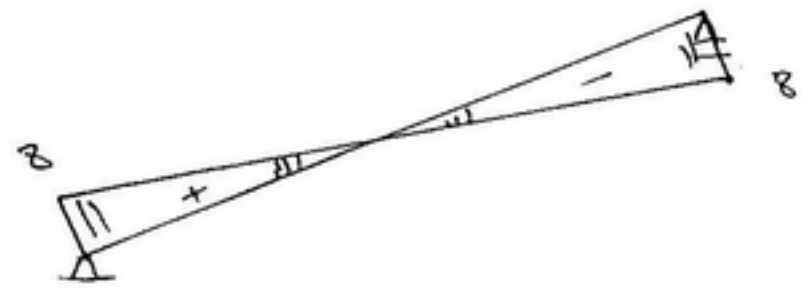
$$\Rightarrow Y_A = 10 \text{ ton}$$



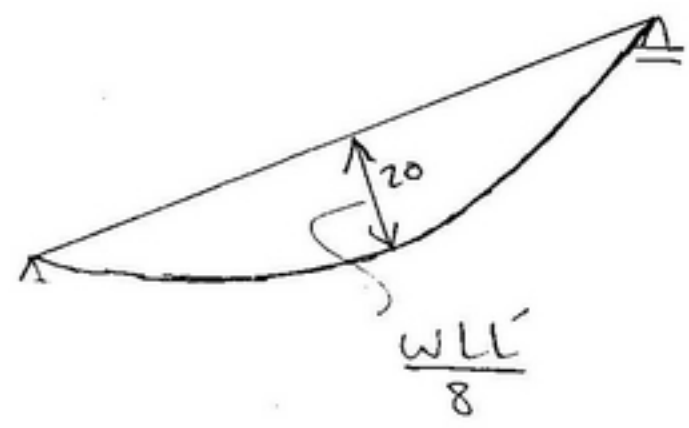
Nf.D

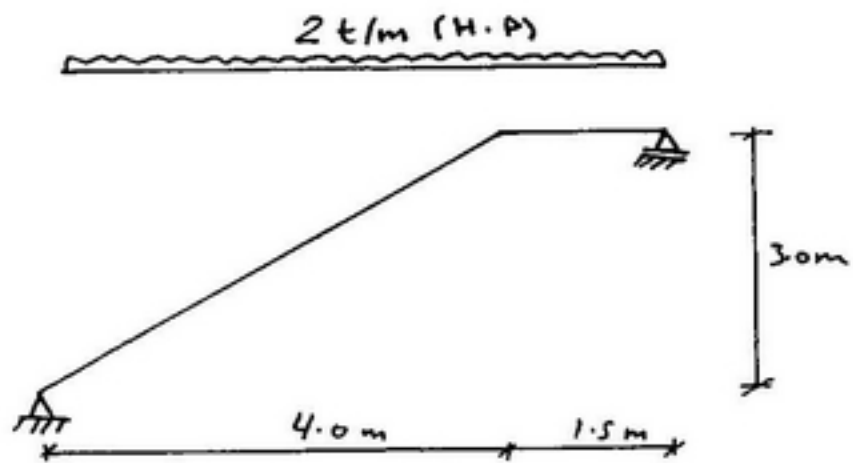


S.f.D



B.M.D





draw N.F.D, B.M.D and S.F.D

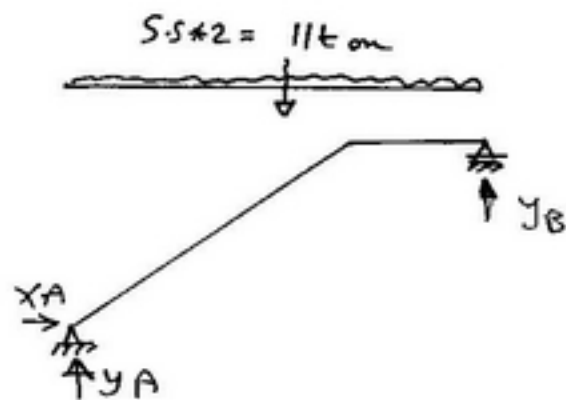
— sol —

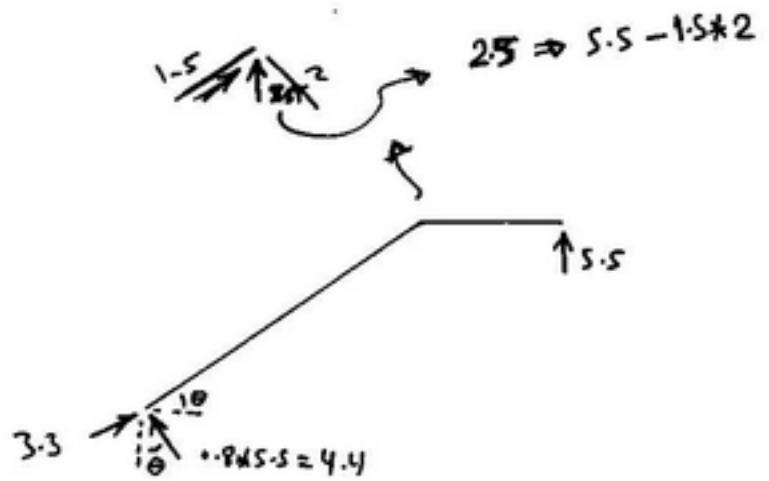
1) Reactions

$$\begin{aligned} * \sum X &= 0 \\ \Rightarrow X_A &= 0 \end{aligned}$$

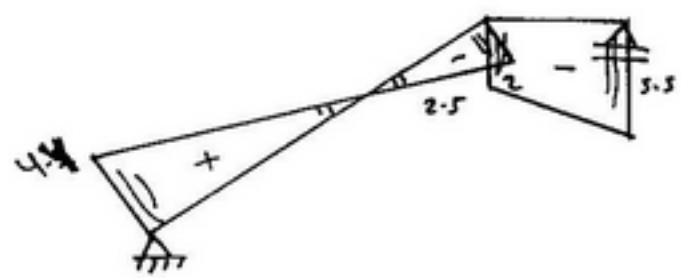
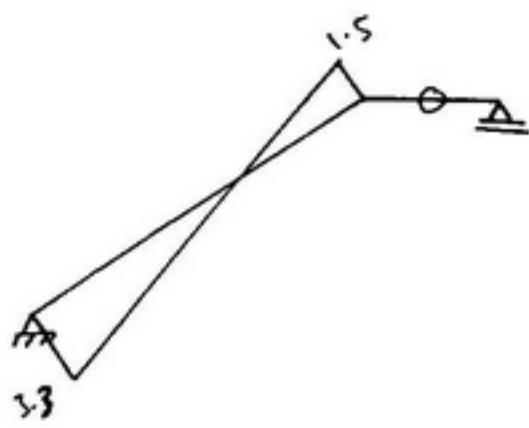
$$\begin{aligned} * \sum M_A &= 0 \\ 11 \times 2.75 &= Y_B \times 5.5 \\ \Rightarrow Y_B &= 5.5 \end{aligned}$$

$$\begin{aligned} * \sum Y &= 0 \\ Y_A &= 5.5 \end{aligned}$$

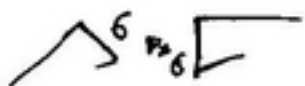




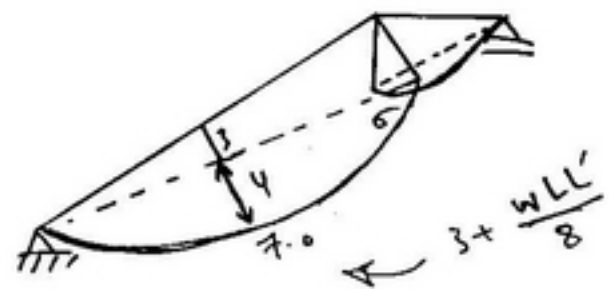
N.F.D



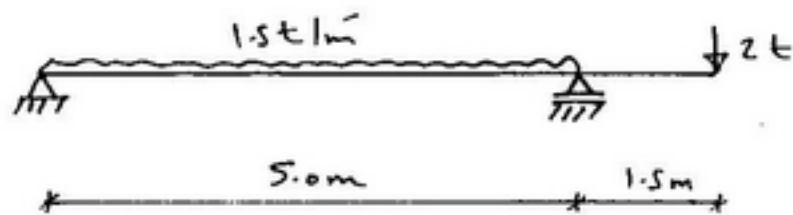
kip



لا زلنا في بيتنا هودا  
على كل سنة الحزنه



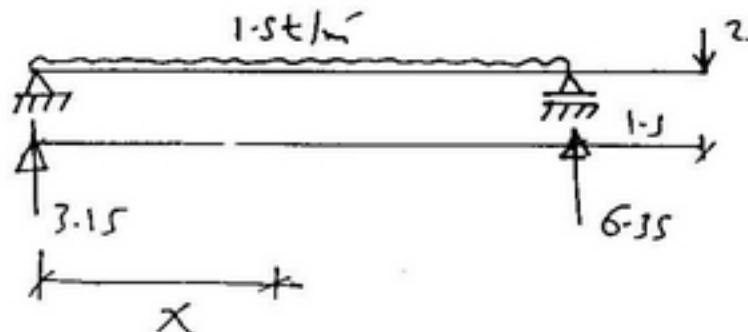
the position of max  
moment



find the position  
and value of  
maximum moment.

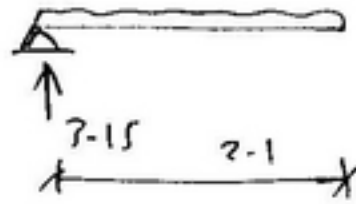
— Sol —

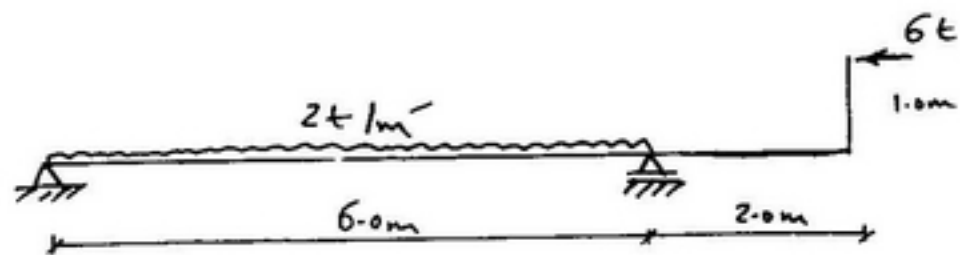
Zero shear.  $\therefore$  is max moment at this point



$$Q = 0.0 \Rightarrow 3.15 - 1.5x = 0.0 \Rightarrow x = 2.1 \text{ m}$$

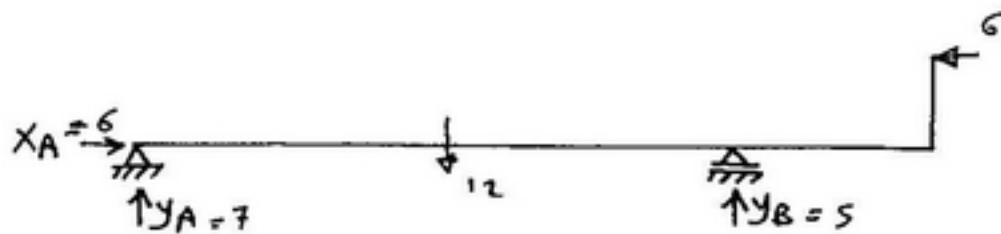
$$\begin{aligned}
 \Rightarrow M &= 3.15 \times 2.1 \\
 &\quad - 1.5 \times 2.1 \times \frac{2.1}{2} \\
 &= 3.3 \text{ t.m}
 \end{aligned}$$





find the position and  
value of max B.M

— Sol —



Reactions

$$\Rightarrow X_A = 6 \text{ ton}$$

$$\Rightarrow \sum M_A = 0.0$$

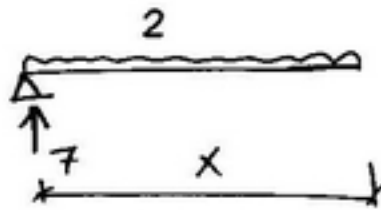
$$12 \times 3 - 6 \times 1 - Y_B \times 6 = 0.0$$

$$\Rightarrow Y_B = 5 \text{ ton}$$

$$\sum Y = 0.0 \Rightarrow Y_A = 7 \text{ ton}$$

(11)

the position of  
zero shear.



$$Q = 0 = 7 - 2x$$

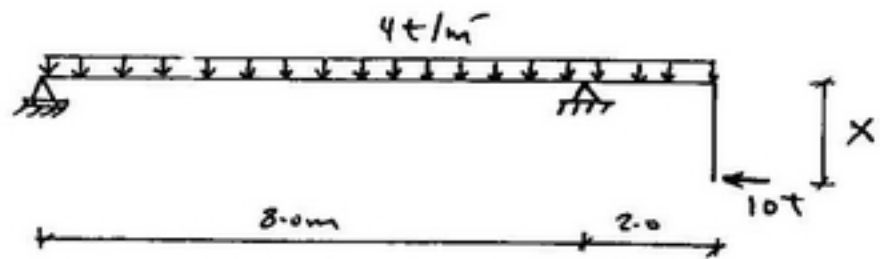
$$\Rightarrow \boxed{x = 3.5 \text{ m}}$$

$$\begin{aligned} \therefore M &= 7 \times 3 - 2 \times 3.5 \times \left(\frac{3.5}{2}\right) \\ &= 8.75 \text{ t.m} \end{aligned}$$

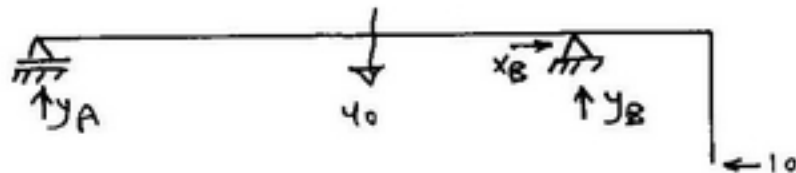


Final 2001

Find the distance (X) so that the maximum (+ve) and (-ve) B.M are equal.



Find Reactions



$$\sum X = 0 \Rightarrow x_B = 1.0$$

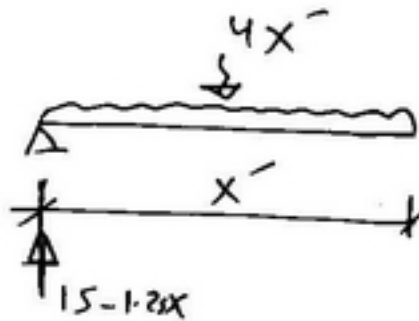
$$\sum M_A = 0 \Rightarrow 40 \times 5 + 10 \times X - y_B \times 8 = 0$$

$$\Rightarrow y_B = 25 + 1.25 X$$

$$\sum Y = 0 \Rightarrow y_A = 40 - 25 - 1.25 X$$

$$y_A = 15 - 1.25 X$$

Position of  
max +ve  
B.M.:-



$$Q_{s.o.o} = 15 - 1.25x - 4x'$$

$$\Rightarrow \boxed{x' = 3.75 - 0.3125x}$$

$$\underline{\underline{\text{max } M_{+ve}}} = (15 - 1.25x) \times [3.75 - 0.3125x] - 4 \frac{[3.75 - 0.3125x]^2}{2}$$

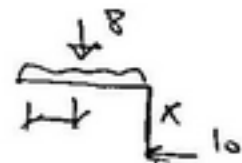
$$= 56.25 - 4.6875x - 4.6875x + 0.39x^2 - 28.125 + 4.6875x - 0.1953x^2$$

$$= 0.194x^2 - 4.6875x + 28.125$$

$$\underline{\underline{\text{max } M_{+ve}}} =$$

$$M = 8 \times 1 + 10x$$

$$= 8 + 10x$$



M+ve & M-ve

$$0.194X^2 - 4.6875X + 28.125 = 8 + 10X$$

$$\Rightarrow 0.194X^2 - 14.6875X + 20.125 = 0$$

$$X = 1.4 \text{ m}$$

بسم الله الرحمن الرحيم

determinacy

there are 3 type of structures:-

(i) stable :- مستقر

{ \*determinate :- عدد معادلات = عدد مجهولات  
\*indeterminate :- عدد معادلات < عدد مجهولات

(ii) unstable :- مستقر نیست

(i) عدد معادلات < عدد مجهولات

(ii) عدد معادلات = عدد مجهولات و کمتر  
یو به جز unstable نمی باشد  
جزایر مستقر

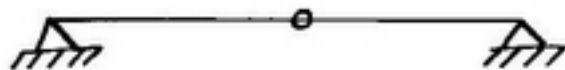
# 1- beams

## الكمات

\* حالات تجعل المنشأ unstable بمجرد التحريك :-

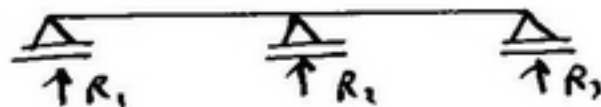
-1

\* هذا الشكل يسمى 3 hinged beam  
وهو غير مستقر لأنه كل المعادلات لا تستطيع الحصول على Reactions



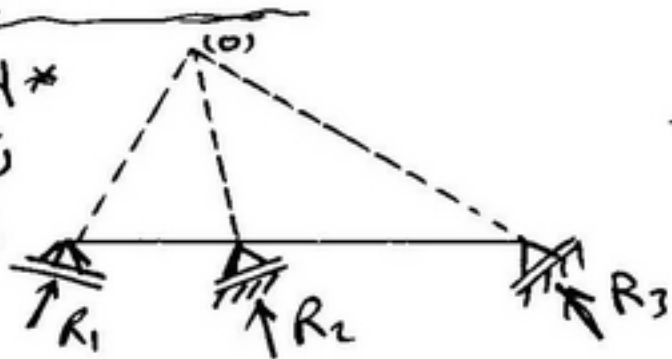
-2

\* هذا المنشأ ثلاث Reactions متوازيه فهو غير مستقر إقلياً حيث أنه قوة لا تستطيع تبعد رد فعل متبادر

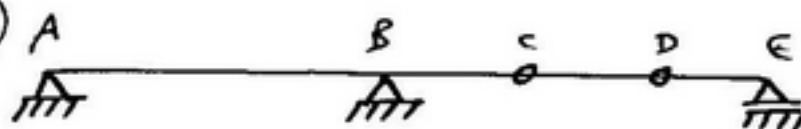


-3

\* ثلاث ردود الافعال متبادلات في نقطة واحدة لو كان هناك ان قوة واحدة اعظم حول (O) فبأنه لا يوجد Reaction معاكس لهذا العزم

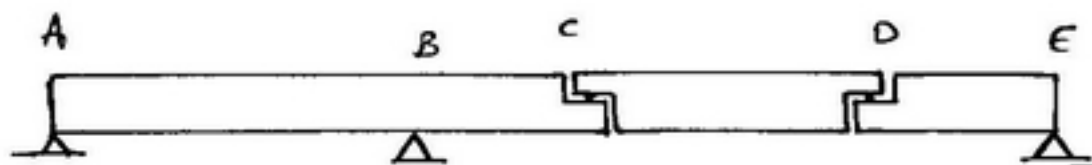


1 مورد 2  
نقطه span

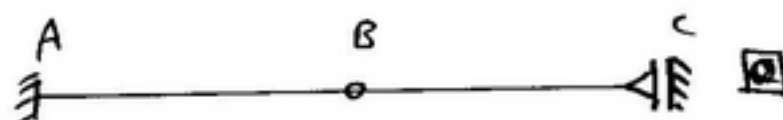


1

مورد 2 intermediate hinge  
به سبب آن  
بخش CD به عنوان یک بخش (بخش) AC  
کنده کند  
بخش DE و بخش DE  
کنده کند D و بخش DE  
آسان است و مستطیع جدا نیست.



unstable ip



2

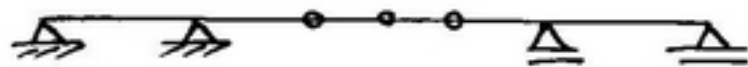
بخش BC به عنوان یک بخش  
unstable  
B  
↓ 5 ton  
2x2

$$\sum M_B = 0 = 5 \times 2$$

معادله نگرش

3

IV



- وجود تکیه میانی Intermediate Support و Span
- چون که این تکیه میانی باعث می‌شود که سیستم ناپایدار شود.



- نقص تکیه میانی

ملاحظه کنید که این سیستم دارای حداقل سه درجه آزادی است



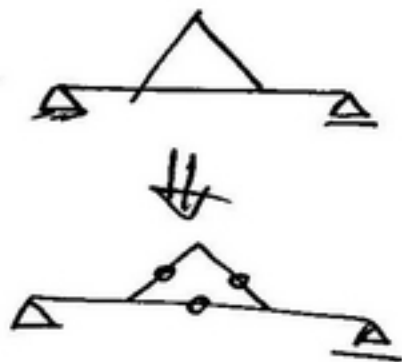
- 3 →  $\sum x = 0$   
 $\sum y = 0$   
 $\sum M_A = 0$
- 2 → درجه آزادی
- 1 → Internal

# \* يتدرج Indeterminate

إذا وجد عدد درجات الحرية أكبر من عدد المعادلات  
، لا يوجد حل لأن حالة التحميل "unstable".

لاحظ حالة وجود أن هذا مغلقة يكون به ثلاث محاور

3 indeterminate ←

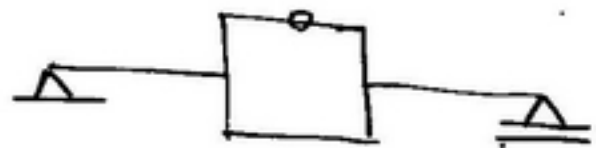


نضع ثلاث intermediate للوصل

لنضع stable

determines

هذا الشكل يوجد به محاور  
ثلاثة



2 indeterminate

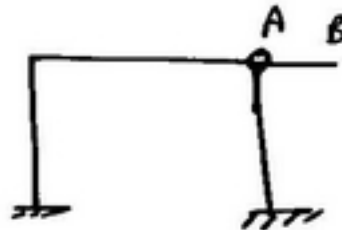
5



## 2- Frames

فالات عدم استقرار

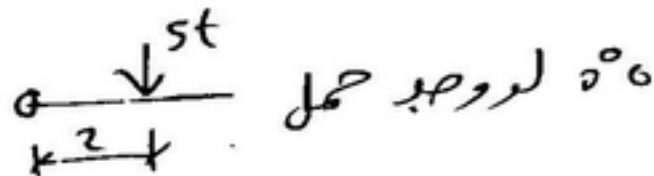
١ وجود جذر unstable في



هذا الجذر Cantilever دافعي

بدائية في interm- وبالتالي فترض

$$\sum M_{AR} = 0$$



$$\sum M_{AR} = 0 = 5 \times 2$$

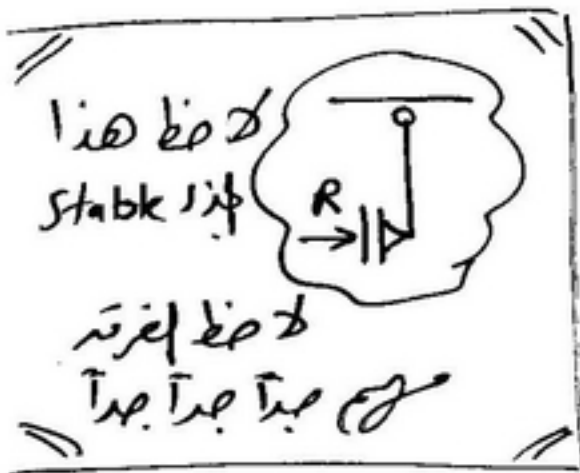
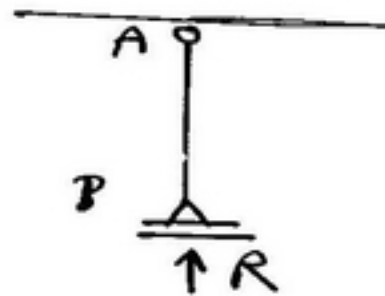
unstable

unstable

⑤, موجود ہیں ~ Frame بہ اسی - Intermediate, زیر

Reaction Roller, رولر واکنش

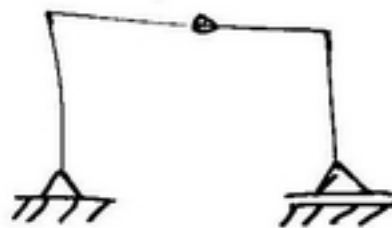
هذا الجذر في مستر



۳۳. مردان و زنان با هم در یک کلاس درس

البرية عند راجع

ok

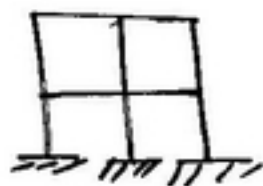


7

Indeterminat  $\neq$  Frame + مگر نه

□ مگر نه در تعداد  $>$  نه در جاهل

ولا يوجد به مگر unstable .



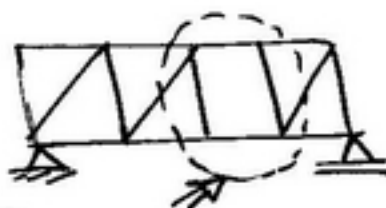
□ مگر نه Close box

كل مگر نه به ثلاث جاهل .

3-truss

ثلاث است جعل + truss مگر نه

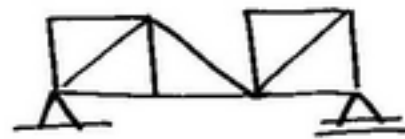
1- وجو مربع بدون مگر diagonal



□

٥ نقله فضل اسماً تعبر (Intermediate)


بجتر در تعداد = 4.0  
در درجه ایل = 3.0



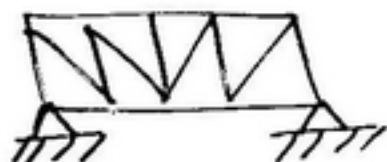
unstable



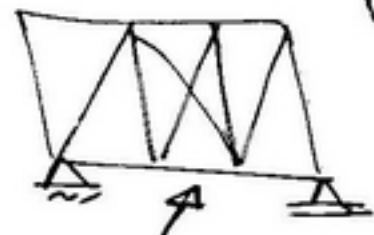
هنا عدد اعداد  $t$  : عدد حاصل

beam  die ist unstatisch,

Indeterminate truss 2D, 3D



## الحالة العادية

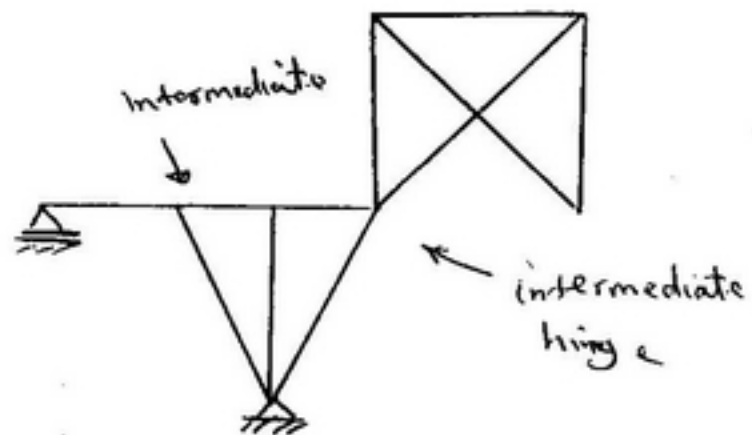


Cross

৭

final 2004

(ii)



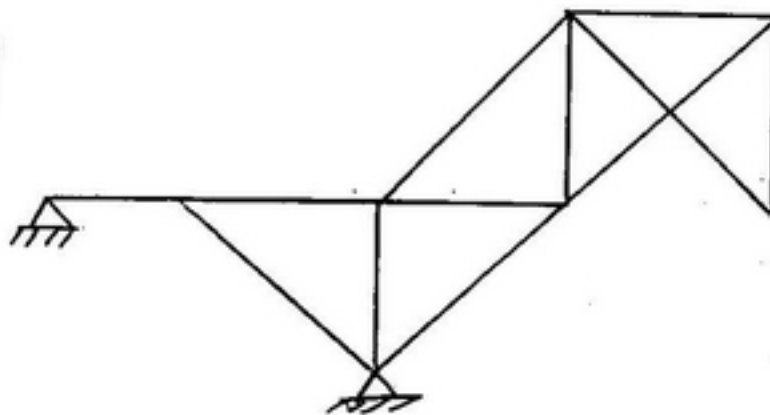
$$2+3 = 5 \text{ degrees of freedom}$$

 $S =$ 

$$3 = \text{degrees of freedom}$$

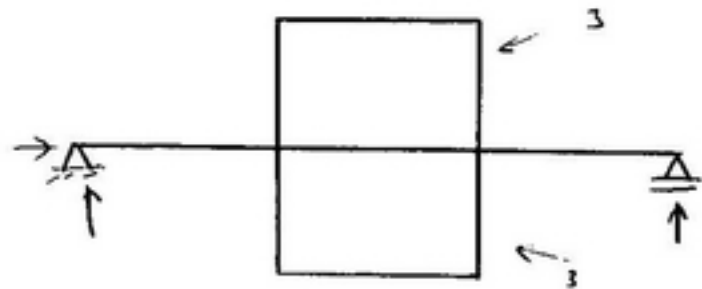
unstable

جواب



(11)

(iii)

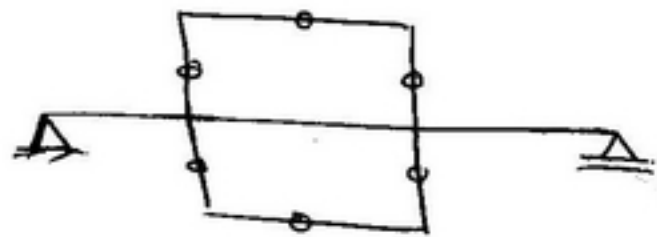


Stable & indeterminate

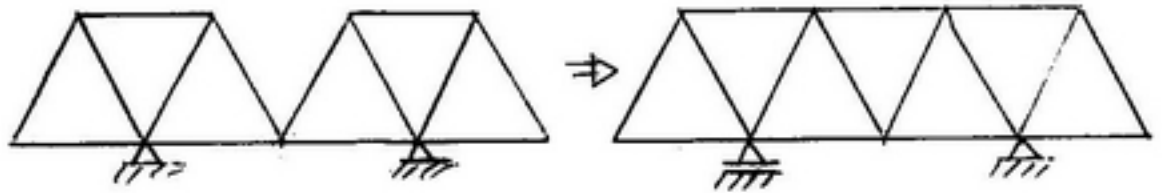
No of equations = 3

No of unknowns =  $3 + 3 + 3 = 9$

∴ 6 indeterminate



(12)



يعتبر 3 hinged على نفس المستوى

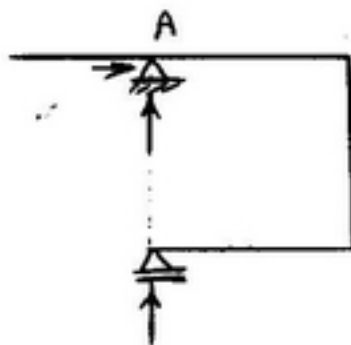
والتي هي (unstable)

كل اربعة اسامع عدد اسامع لا ت

= عدد اسامع = 4.0

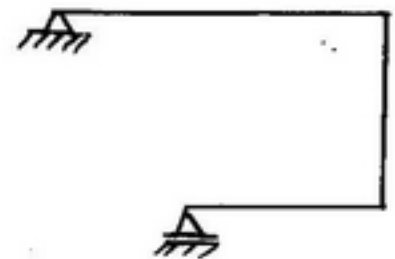


لغير



(unstable)

لا يمكن ان تكون، عدد اسامع متلاقى  
في نقطة

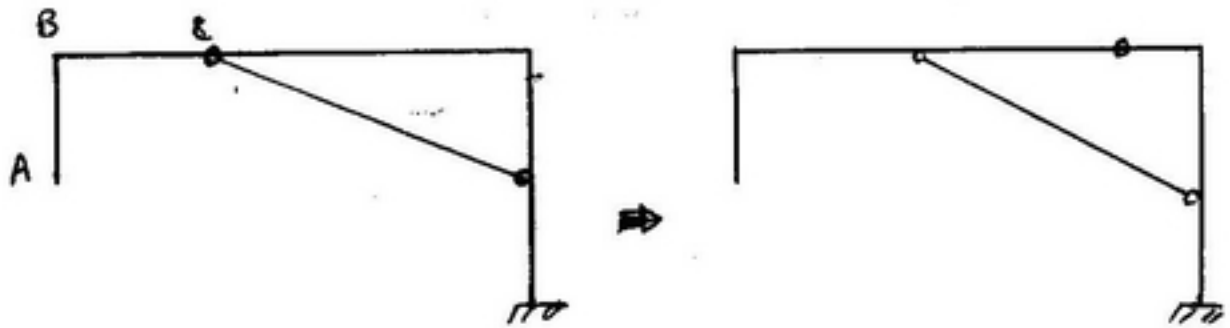


لغير

تكون

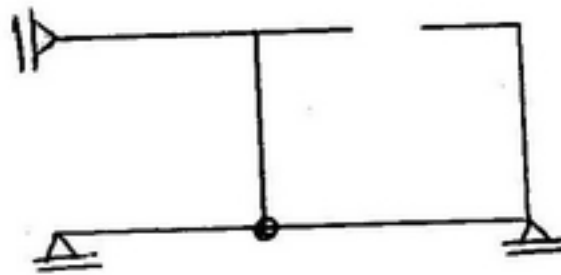
Stable & determinate





unstable ABC & if

unstable at hinge

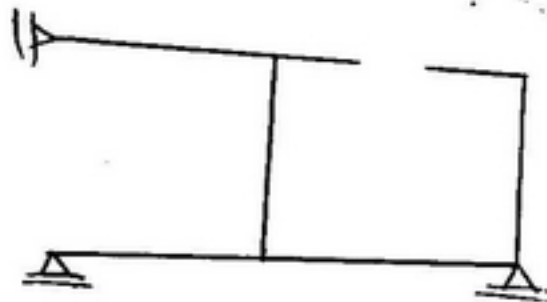


$S_o = 2 + 3 =$  در درجات

3 = در درجات

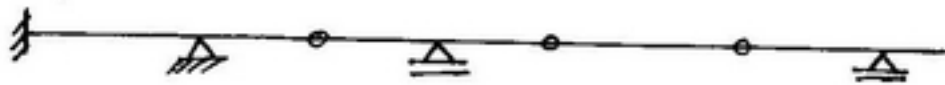


unstable

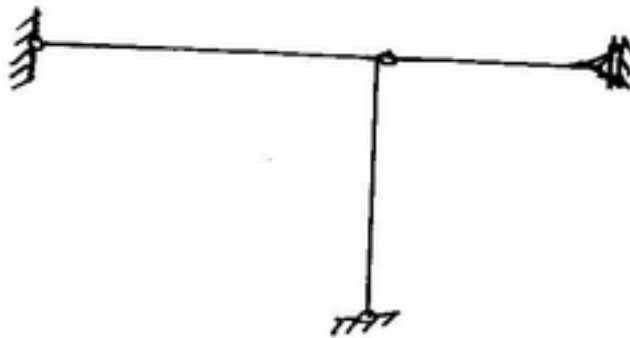


\* check the stability & determinacy for the given structure. and if not (stable & determinate) what do you want to do.

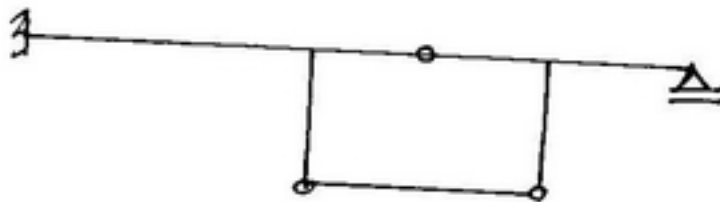
a



b



c



(15)

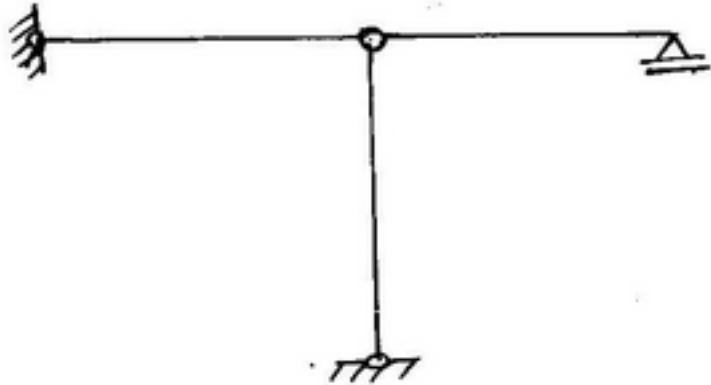
For aunstable

2 internal 2-span & 3

For bunstable

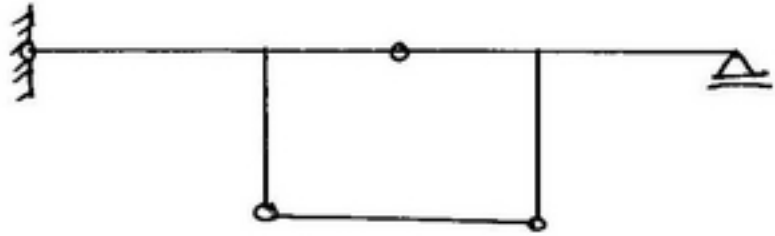
Reaction is not in the direction of the member  
Reaction is not in the direction of the member

بازیل



For  $c_3$  stable but indeterminate

↓  
استقر



# Solved Examples \* أمثلة محلولة \*

7  
41

## Arch

لتفسيح مسائل Arch في امتحان فينوسية :-

1- يعطى Arch ← يتم طلب B.M., S.F., N.F. عند نقطة معينة

يعطى (الارتفاع لنقطة) أو يتم حسابها .

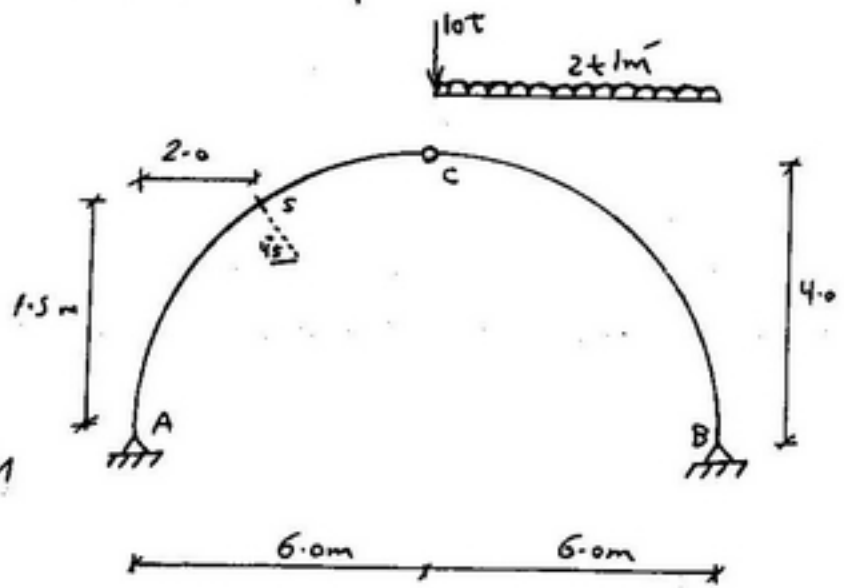
2- يعطى Arch ← يتم طلب B.M.D, S.F.D, N.F.D على كامل

Arch

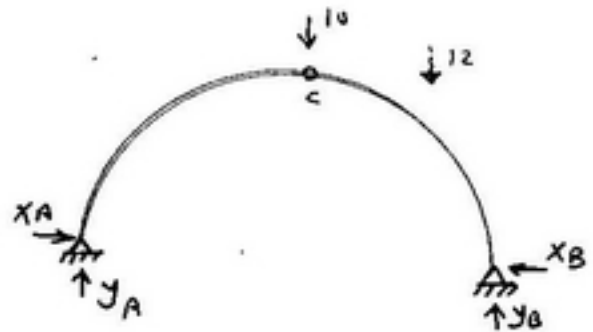
### Example ①

find N.F., S.F., B.M

at section S



### (1) Reactions



$$* \sum M_A = 0.0$$

$$10 \times 6 + 12 \times 9 - Y_B \times 12 = 0.0$$

$$Y_B = 14.0 \text{ ton.}$$

$$* \sum M_{C_R} = 0.0$$

$$12 \times 3 - 14 \times 6 + X_B \times 4 = 0.0$$

$$X_B = 12.0 \text{ ton.}$$

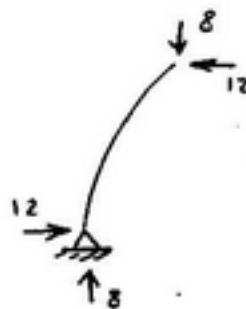
$$* \sum Y = 0.0$$

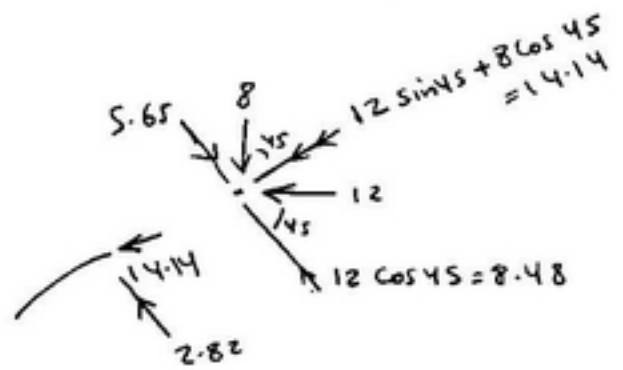
$$Y_A = 10 + 12 - 14 = 8 \text{ ton.}$$

$$* \sum X = 0.0$$

$$X_A = 12.0 \text{ ton.}$$

### (2) N.F, B.M, s-f





$$N.F = -14.14 \quad \text{كبح}$$

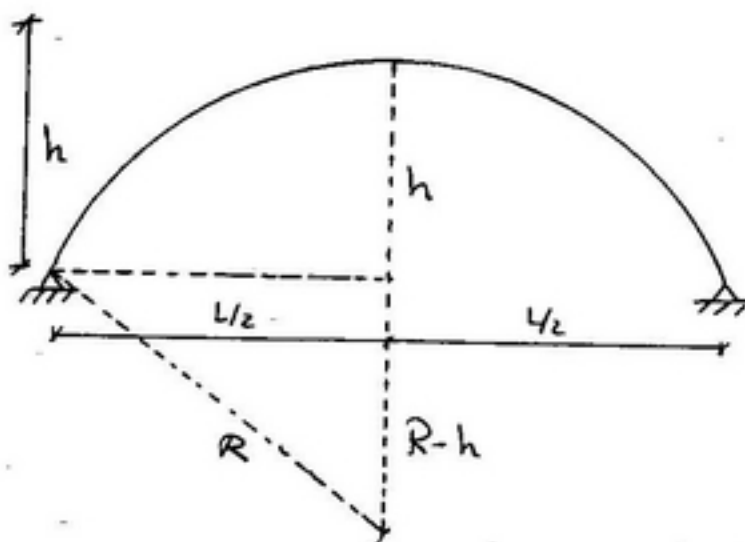
$$S.F = -2.82 \quad \text{قوة طالع}$$

$$B.M = -12 \times 1.5 + 8 \times 2$$

$$= -2 \text{ t.m}$$

## For Circular Arch

يقطع المسار الزاوية عند الارتفاع



(i) obtain  $R$  "Radius"

$$R^2 = \left(\frac{L}{2}\right)^2 + (R-h)^2$$

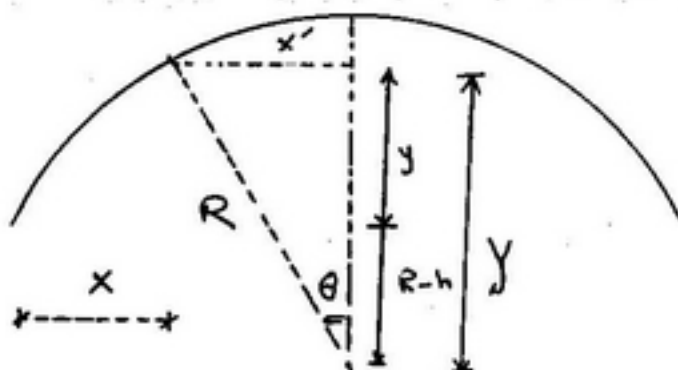
(ii) given  $x$  for any point you can find  $\theta$

$$x' = \frac{L}{2} - x$$

$$y = \sqrt{R^2 - x'^2}$$

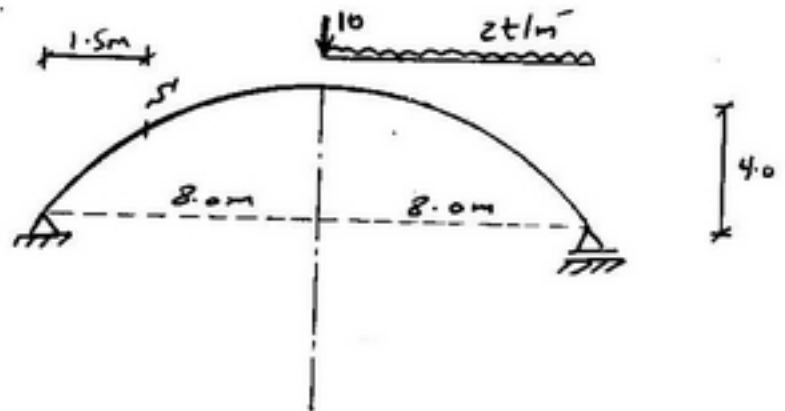
$$y = y - (R-h)$$

$$\theta = \tan^{-1}\left(\frac{x'}{y}\right)$$





find N.f, s.f  
B.M  
at sections.



———— Sol ————

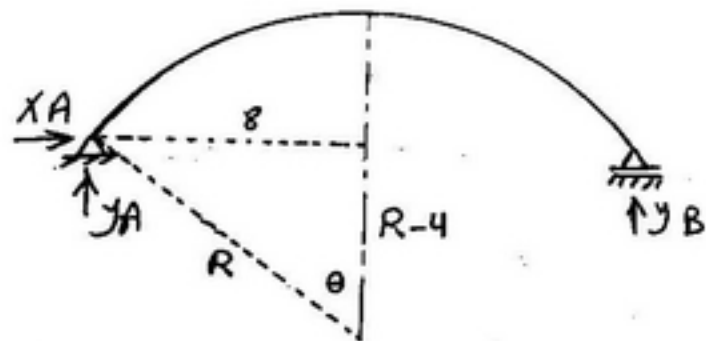
Get R

$$R^2 = 8^2 + (R-4)^2$$

$$R^2 = 64 + R^2 - 8R + 16$$

$$8R = 80$$

$$R = 10\text{ m}$$



$$\theta = \tan^{-1} \left( \frac{8}{6} \right) = 53.13^\circ$$

Find Reaction

$$\sum X = 0$$

$$\Rightarrow X_A = 0$$

$$\sum M_A = 0 \dots$$

$$\Rightarrow 10 \times 8 + 16 \times 12 - Y_B \times 16 = 0 \dots$$

$$\Rightarrow Y_B = 17 \text{ ton}.$$

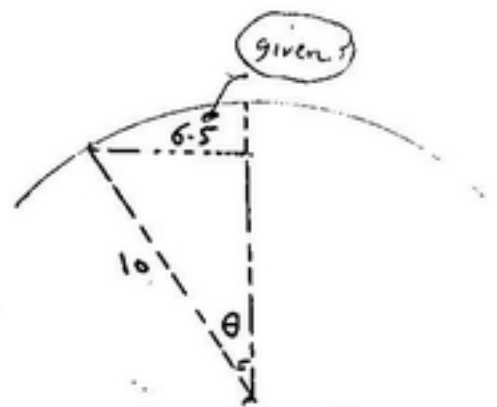
$$\sum Y = 0 \dots$$

$$\Rightarrow Y_A = 26 - 17 = 9 \text{ ton}.$$

Finding N.F, B.M, S.F

$$\theta = \sin^{-1}\left(\frac{6.5}{10}\right) = 40.5 \Rightarrow \cos \theta = 0.76$$

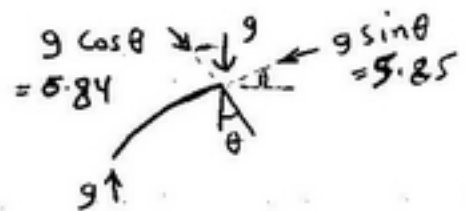
$$\Rightarrow \sin \theta = 0.65$$



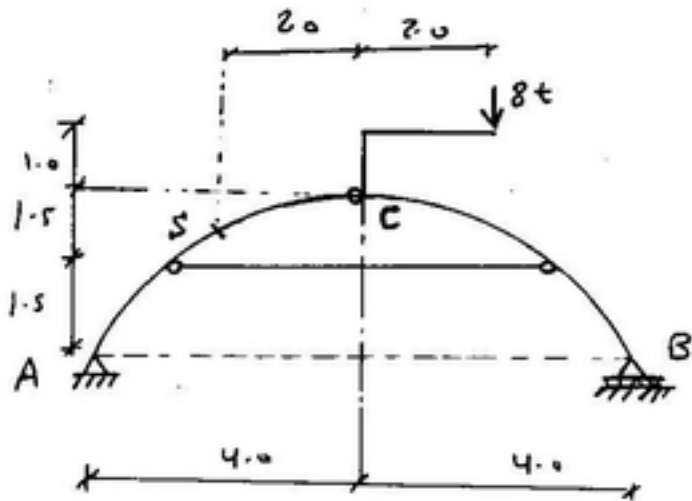
$$N = -5.85 \text{ t}$$

$$S.F = +5.84 \text{ t}$$

$$B.M = 9 \times 1.5 = 13.5 \text{ t.m}$$



Final 2004



For the following Arch calculate  
N.F, S.F and  
B.M at section "S"

Sol

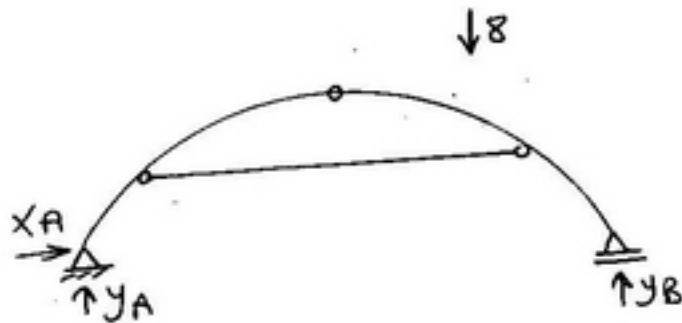
### Finding Radius (R)

$$R^2 = (R-h)^2 + (L/2)^2$$

$$R^2 = (R-3)^2 + 4^2$$

$R = 5.0 \text{ m}$

For Reactions



$$\times \sum X = 0.0$$

$$\Rightarrow X_A = 0.0$$

$$\times \sum M_A = 0.0$$

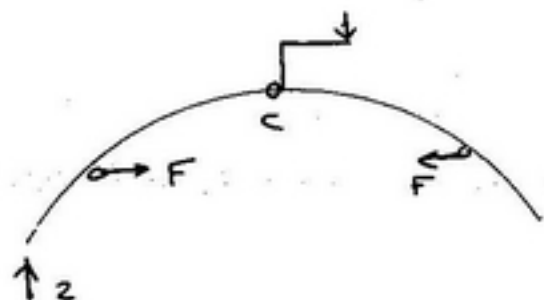
$$\Rightarrow 8 \times 6.0 - Y_B \times 8 = 0.0$$

$$Y_B = 6.0 \text{ ton.}$$

$$\times \sum Y = 0.0$$

$$\Rightarrow Y_A = 8 - 6 = 2.0 \text{ ton.}$$

$$\sum M_C = 0.0$$



$$F \times 1.5 - 2 \times 4 = 0.0$$

$$\Rightarrow F = 5.33 \text{ ton.}$$

For  $\theta$  at section (S')

$$\theta = \sin^{-1} \left( \frac{2}{5} \right) = 23.5$$

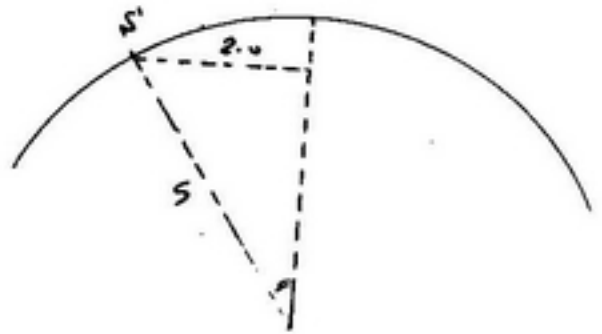
$$\cos \theta = 0.916$$

$$\sin \theta = 0.4$$

$$N = -[2 \sin \theta + 5.33 \cos \theta]$$
$$= 5.682 \text{ ton}$$

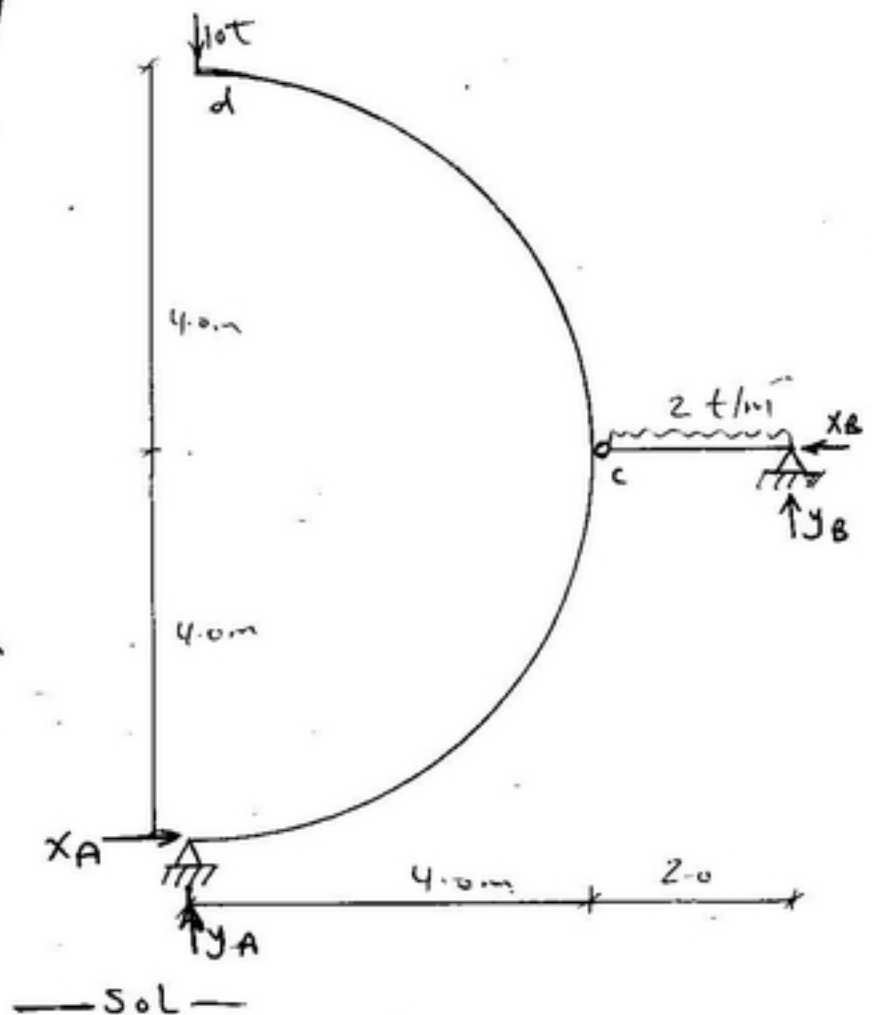
$$S.F. = 2 \cos \theta - 5.33 \sin \theta$$
$$= -0.3$$

$$B.M. = 2 \times 2 - 5.33 \times 1.5$$
$$= -4 \text{ t.m}$$



For the following  
Arched-frame  
draw N.F.D  
S.F.D and B.M.D

الهيكل يوجد بداره من نصف  
دائرة



$$\sum M_{C_R} = 0$$

$$\Rightarrow 2 \times 2 \times 1 - Y_B \times 2 = 0$$

$$\Rightarrow Y_B = 2 \text{ ton}$$

$$\sum M_A = 0$$

$$\Rightarrow 4 \times 5 - 2 \times 6 - X_B \times 4 = 0$$

$$\Rightarrow X_B = 2 \text{ ton}$$

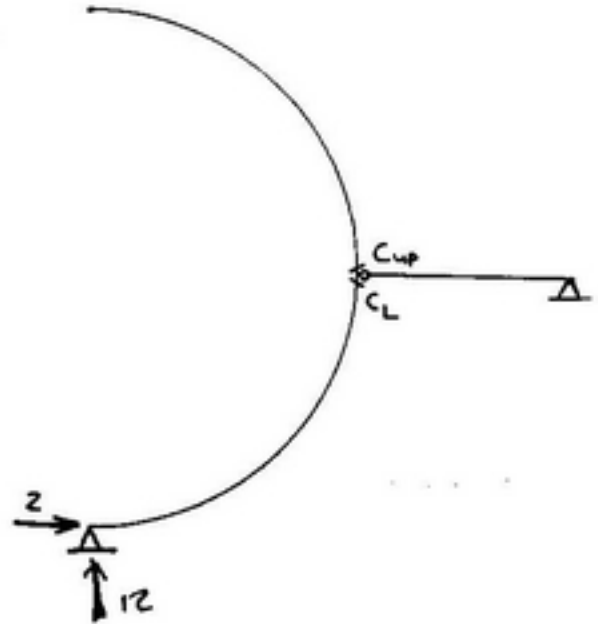
(10)

$$\sum x = 0$$

$$\Rightarrow X_A = 2.0 \text{ ton.}$$

$$* \sum y = 0$$

$$\Rightarrow y_A = 12 \text{ t. on}$$

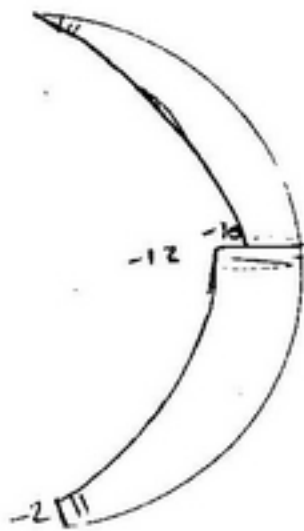


$$\left\{ \begin{array}{l} N_A = -2 \\ N_{CL} = -12 \\ N_{cup} = -10 \\ N_d = 0.0 \end{array} \right.$$

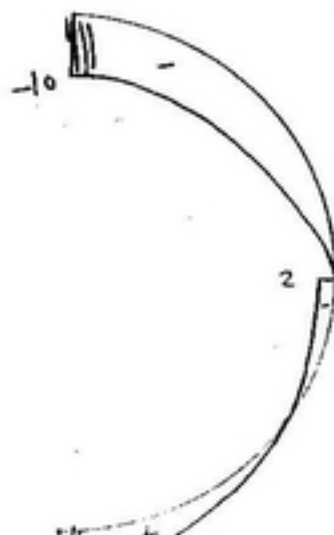
$$\left\{ \begin{array}{l} sh_A = +12 \\ sh_{CL} = -2 \\ sh_{up} = \dots \\ sh_d = -10 \end{array} \right.$$

$$\left\{ \begin{array}{l} M_A = 0.0 \\ M_{CL} = M_{cup} = -10 \times 4 \\ \quad \quad \quad = -40 \\ M_d = 0.0 \end{array} \right.$$

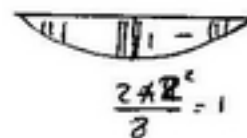
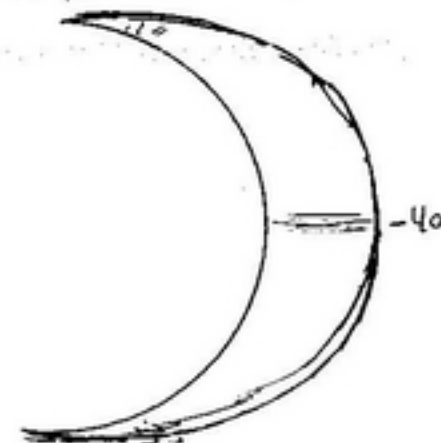




N-F-D



S-F-D



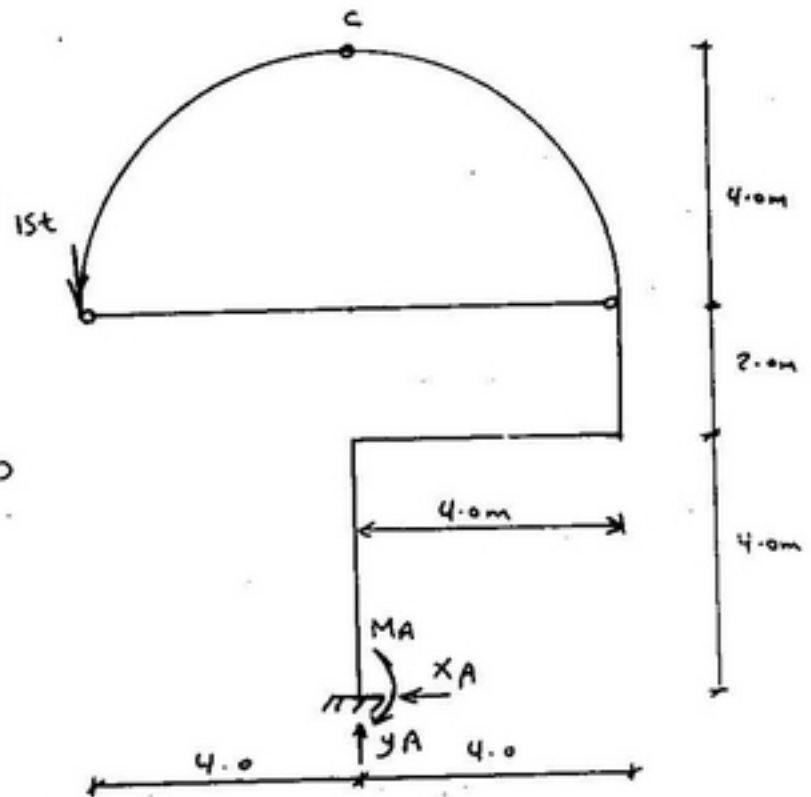
B.M.D



Final 2004

draw B.M.D

N.F.D and N.F.D



— Sol —

$$\begin{aligned} \sum X &= 0 \\ X_A &= 0 \end{aligned}$$

$$\begin{aligned} \sum Y &= 0 \\ Y_A &= 15t \end{aligned}$$

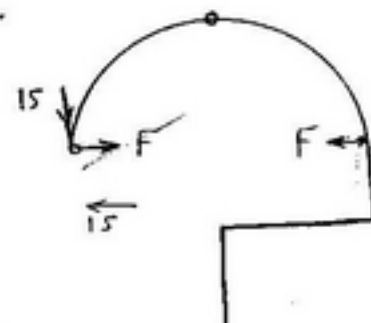
$$\sum M_A = 0$$

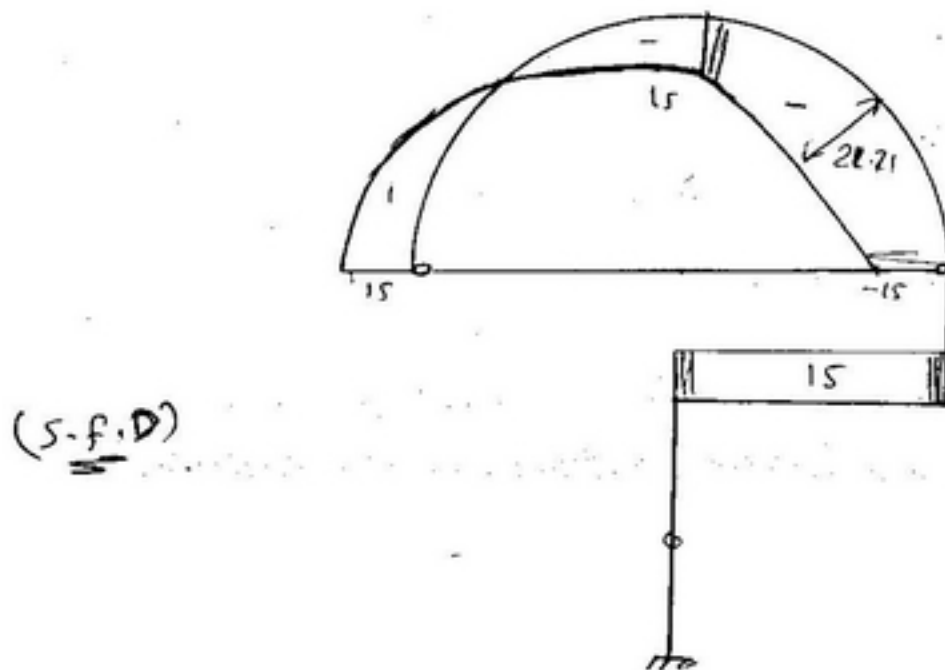
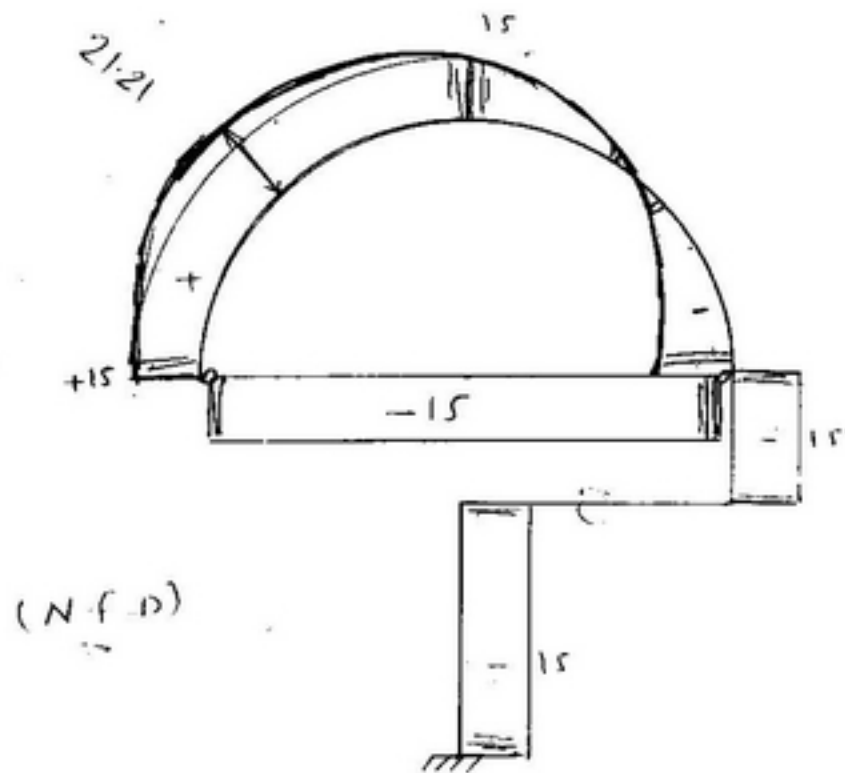
$$M_A = 15 \times 4 = 60 \text{ t.m.}$$

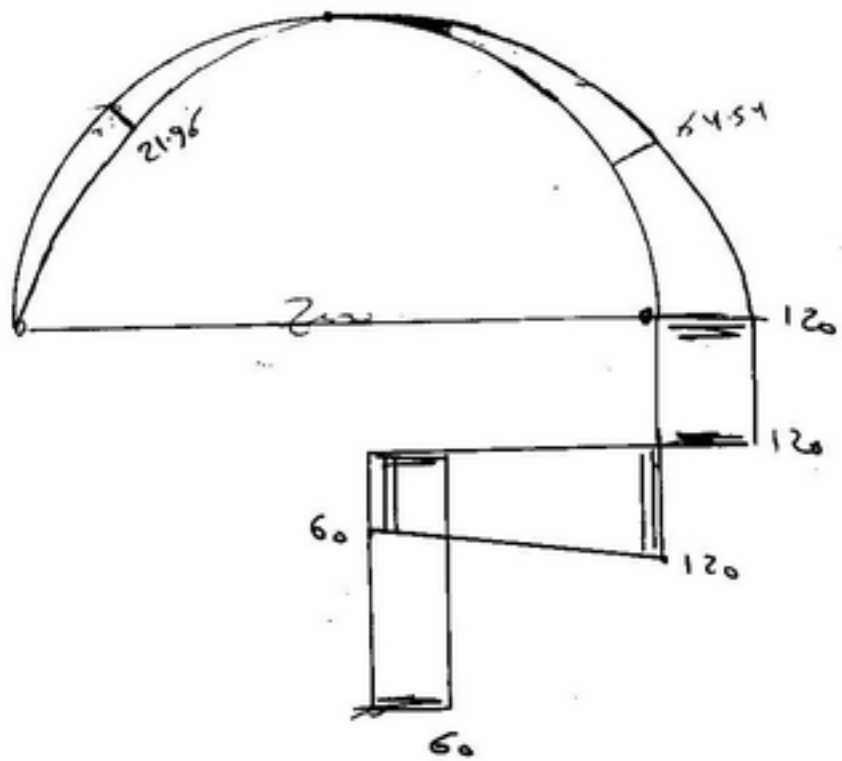
$$\sum M_C = 0$$

$$F \times 4 + 15 \times 4 = 0$$

$$F = -15 \text{ t.m.}$$

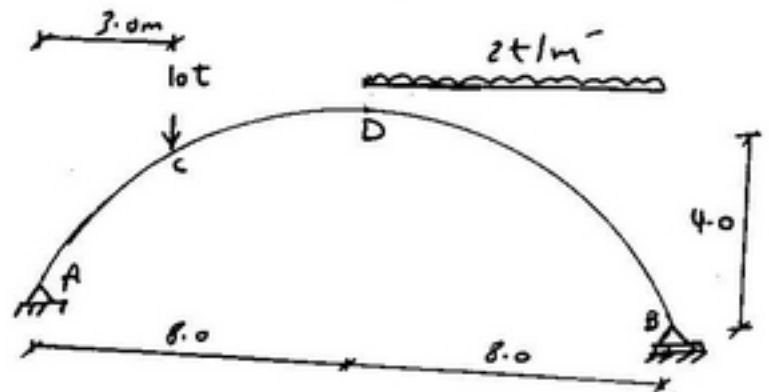






B.M.D

draw  
N.f.D, S.f.D  
and B.M.D



———— Sol ———

Finding (R)

$$R^2 = (R - h)^2 + (L/2)^2$$

$$R^2 = R^2 - 8R + 16 + 64$$

$$R = 10 \text{ m}$$

For Reactions

$$\sum F_x = 0$$

$$\Rightarrow X_A = 0$$

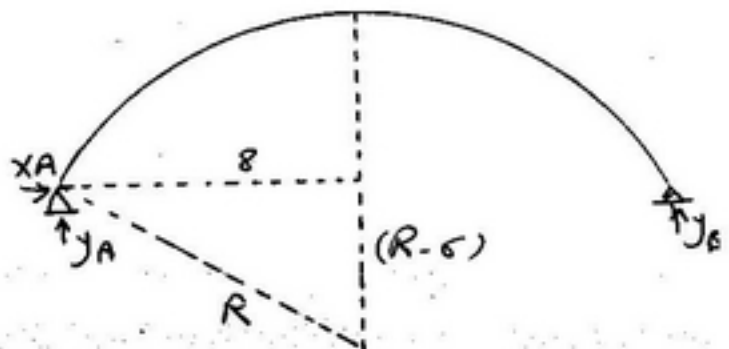
$$\sum M_A = 0$$

$$10 \times 3 + 16 \times 12 - Y_B \times 16 = 0$$

$$\Rightarrow Y_B = 13.875 \text{ ton}$$

$$\sum Y = 0$$

$$\Rightarrow Y_A = 12.125 \text{ ton}$$



$$\theta \text{ at point A} \Rightarrow \sin^{-1}\left(\frac{8}{10}\right) = 53.13^\circ$$

$$\theta \text{ at point (c)} \Rightarrow \sin^{-1}\left(\frac{5}{10}\right) = 30^\circ$$

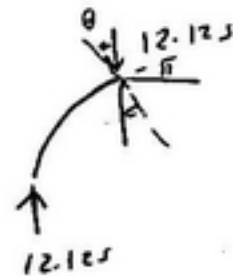
$$\theta \text{ at point (D)} \Rightarrow 0.0$$

From A  $\rightarrow$  C

$$\text{From } \theta = 53.13^\circ \Rightarrow \theta = 30^\circ$$

$$* N = -12.125 \sin \theta$$

$$\begin{cases} N_A = -12.125 (\sin 53.13) = -9.7 \text{ t} \\ N_C = -12.125 [\sin 30] = -6.06 \text{ t} \end{cases}$$



$$* S.F = +12.125 \cos \theta$$

$$\begin{cases} S.F_A = +12.125 (0.6) = 7.275 \text{ t} \\ S.F_C = +12.125 (0.866) = 10.5 \text{ t} \end{cases}$$

$$* \begin{cases} B.M_A = 0.0 \end{cases}$$

$$\begin{cases} B.M_C = 12.125 \times 3 = 36.375 \end{cases}$$

From c  $\rightarrow$  d

$$\theta = 30^\circ \rightarrow \theta = 0.0$$

$$N = -2.125 \sin \theta$$

$$\begin{cases} N_c = -1.06 \\ N_d = 0.0 \end{cases}$$

$$S.F = 2.125 \cos \theta$$

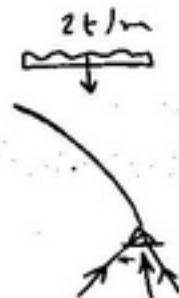
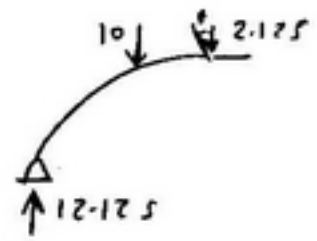
$$\begin{cases} SF_c = 1.84 \\ SF_d = 2.125 \end{cases}$$

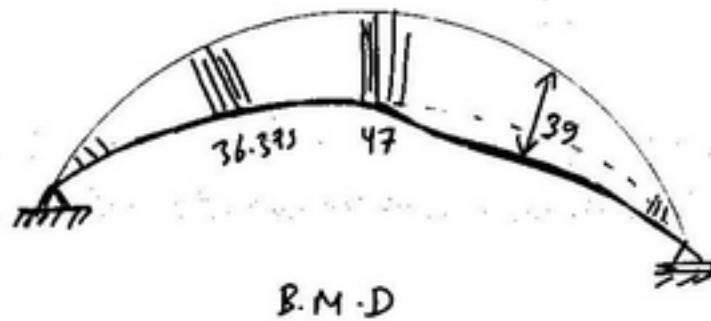
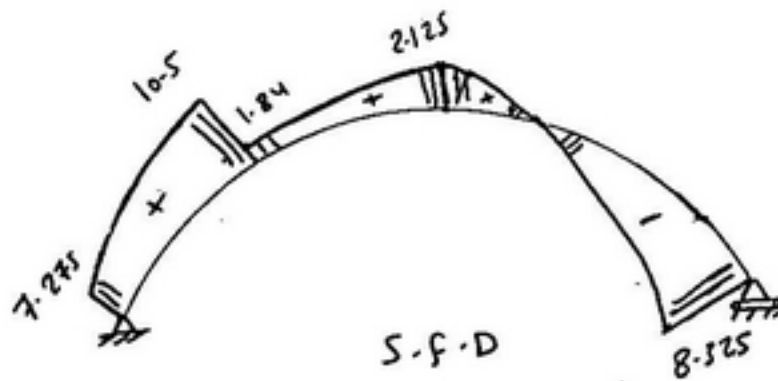
$$B.M_d = 12.125 \times 8 - 10 \times 5 = 47 \text{ t.m}$$

From d  $\rightarrow$  B

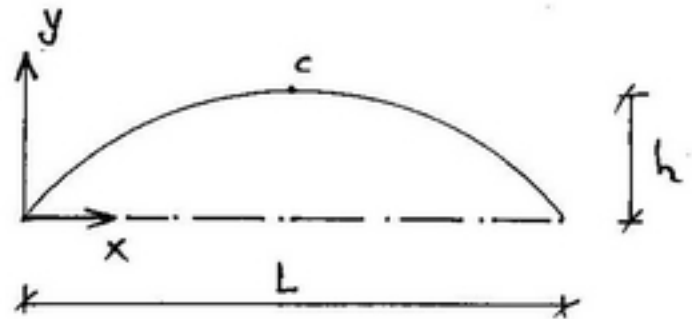
$$\begin{cases} N_d = 0.0 \\ N_B = -13.875 \sin (53.13) = -11.1 \end{cases}$$

$$\begin{cases} S.F)_d = 1.84 \\ S.F)_B = -13.875 \times \cos (53.13) = -8.325 \end{cases}$$





# Parabolic arch



$$y = ax^2 + bx + c$$

Req  $a, b, c$

\* at  $x = 0 \Rightarrow y = 0$

$\therefore \Rightarrow c = 0$

\* at  $x = L \Rightarrow y = 0$

$\therefore 0 = aL^2 + bL$

$\therefore b = -aL$



$$\text{at } x = \frac{L}{2} \Rightarrow y = h$$

$$\Rightarrow h = a \left(\frac{L}{2}\right)^2 + b \left(\frac{L}{2}\right)$$

$$h = a \frac{L^2}{4} - \frac{aL^2}{2}$$

$$\{ h = -\frac{aL^2}{4} \}$$

$$\Rightarrow a = -\frac{4h}{L^2}$$

$$\Rightarrow b = \frac{4h}{L}$$

$$\therefore \boxed{y = -\frac{4h}{L^2} \cdot x^2 + \frac{4h}{L} \cdot x}$$

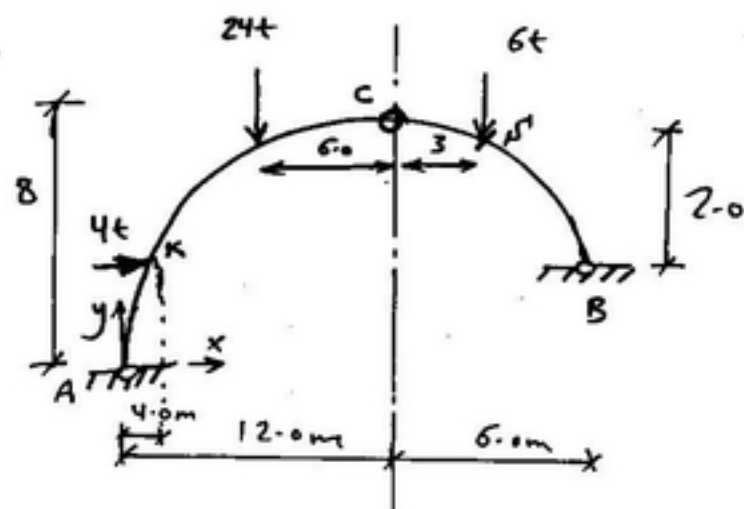
$$y = +\frac{4h}{L} \left[ x - \frac{x^2}{L} \right]$$

$$\tan \theta = \frac{dy}{dx} = \frac{4h}{L} \left[ 1 - \frac{2x}{L} \right]$$

find  $\theta$

## Example

Required :-  
N-f, B.M, s-f  
at section S'



— Sol —

$$y = ax^2 + bx + c$$

$$\text{at } x=0 \Rightarrow y=0.0$$

$$\Rightarrow C=0.0$$

$$\text{at } x=18 \Rightarrow y=6.0 \text{ m}$$

$$\Rightarrow 6.0 = a(18)^2 + b(18)$$

$$\Rightarrow b = \frac{1}{3} - 18a$$

$$\text{at } x=12 \Rightarrow y=8.0$$

$$8 = a(12)^2 + \left(\frac{1}{3} - 18a\right)(12)$$

$$8 = 144a + 4 - 216a$$

$$\Rightarrow 72a = -4$$

$$\Rightarrow \boxed{a = -\frac{1}{18}}$$

$$\text{so } b = \frac{1}{3} + \frac{18}{18} = \boxed{+\frac{4}{3}}$$

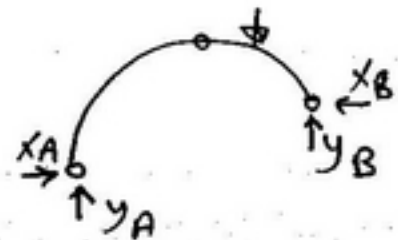
$$\underline{\underline{\circ \circ}} \quad \boxed{y = -\frac{1}{18} x^2 + \frac{4}{3} x}$$

$$\text{for point K} \Rightarrow x = 4.0 \Rightarrow y = 4.44 \text{ m}$$

$$\text{for point S} \Rightarrow x = 15.0 \Rightarrow y = 7.5 \text{ m}$$

Reactions

$$\sum M_{CK} = 0 \dots$$



$$6 \times 3 + X_B \times 2 - y_B \times 6 = 0 \dots$$

$$\Rightarrow \boxed{2X_B - 6y_B = -18} \rightarrow \textcircled{1}$$

$$\sum M_A = 0 \dots$$

$$4 \times 4.44 + 24 \times 6 + 6 \times 15 - X_B \times 6 - Y_B \times 18 = 0 \dots$$

$$6X_B + 18Y_B = 251.78 \longrightarrow (2)$$

By solve (1) & (2)

$$X_B = 16.48 \text{ ton}$$

$$Y_B = 8.5$$

$$\sum X = 0 \dots \Rightarrow X_A = 12.48$$

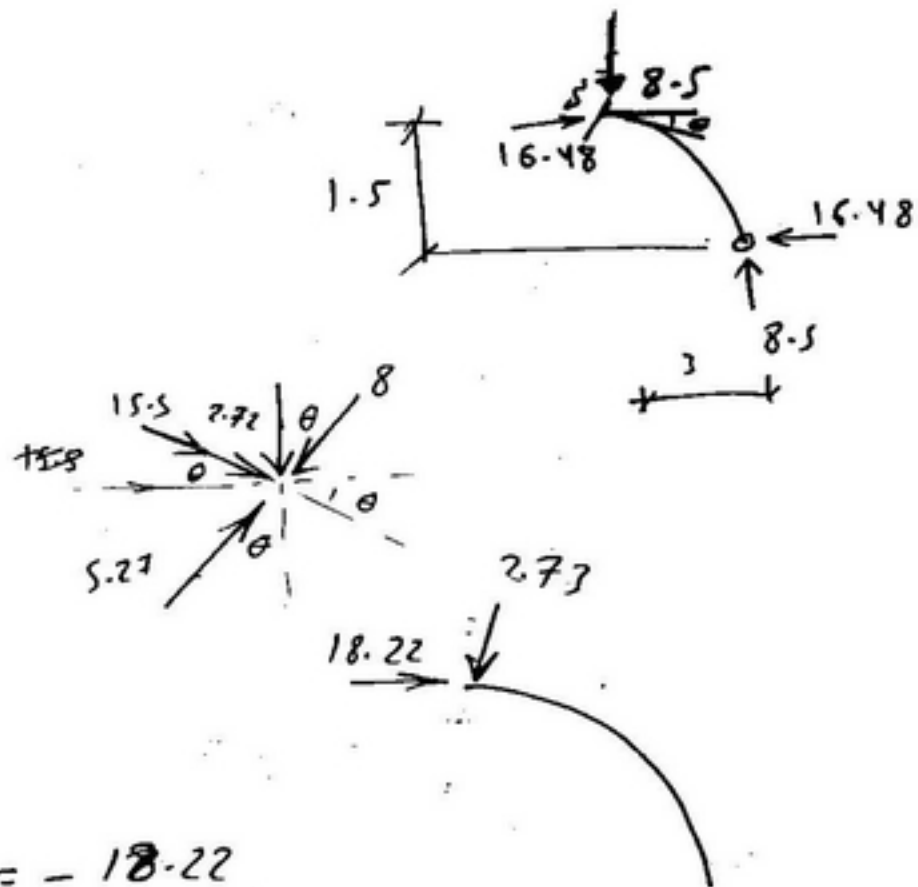
$$\sum Y = 0 \dots \Rightarrow Y_A = 21.5$$

at section S' (X = 15)

$$\begin{aligned} \tan \theta &= \frac{dy}{dx} = -\frac{2}{18}X + \frac{4}{3} \\ &= -\frac{2}{18}(15) + \frac{4}{3} = -\frac{1}{3} \end{aligned}$$

$$\therefore \theta = -18.4 \quad \Rightarrow \cos \theta = 0.94$$

$$\sin \theta = 0.32$$



$$N.f = -18.22$$

$$S.f = -2.73$$

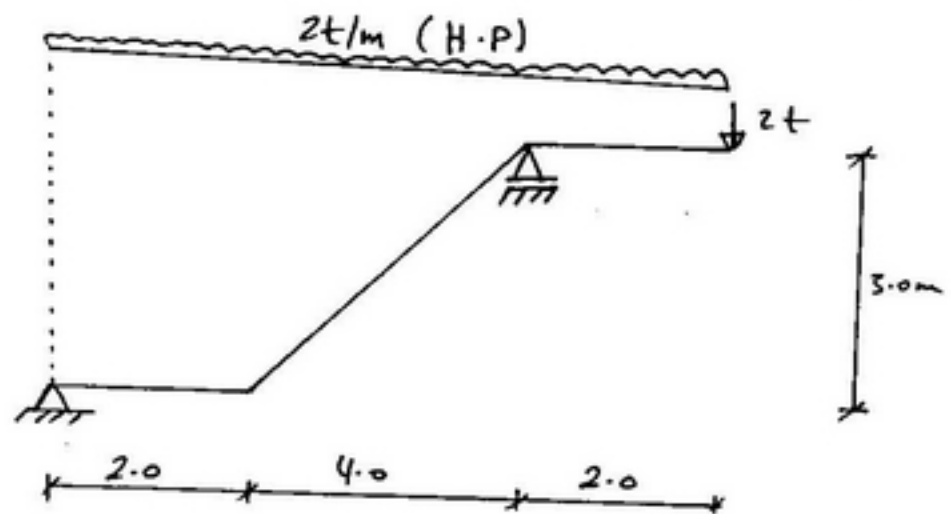
$$B.M = +8.5 \times 3 - 16.48 \times 1.5$$

$$= +0.78$$

beams

II For the following beam draw

N.F.D, S.F.D, B.M.D:—



— Sol —

Reactions

$$\Rightarrow \sum X = 0$$

$$X_a = 0$$

$$\Rightarrow \sum M_A = 0$$

$$16 \times 4.0 + 2 \times 8 = Y_b \times 6$$

$$\Rightarrow Y_b = 13.33 \text{ ton}$$

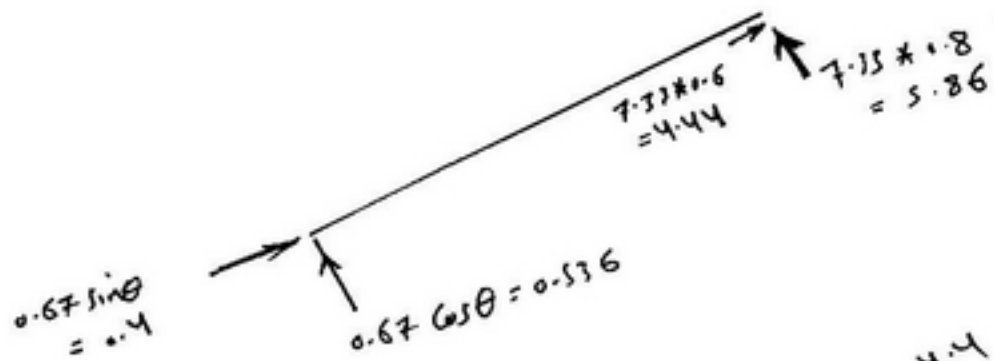
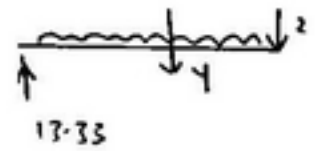
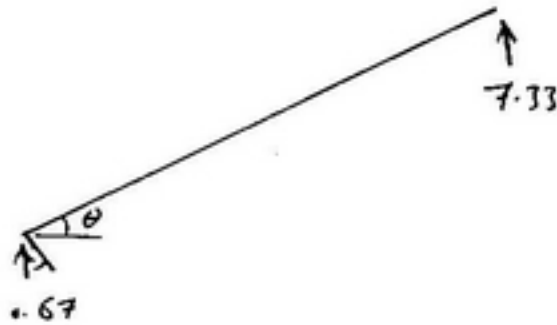
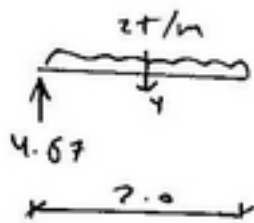
$$\Rightarrow \sum Y = 0$$

$$Y_a + 13.33 = 18 \Rightarrow Y_a = 4.67 \text{ ton}$$

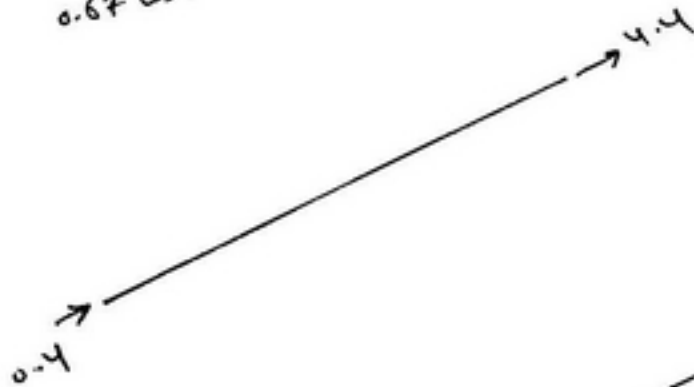
①

$$\cos \theta = 0.8$$

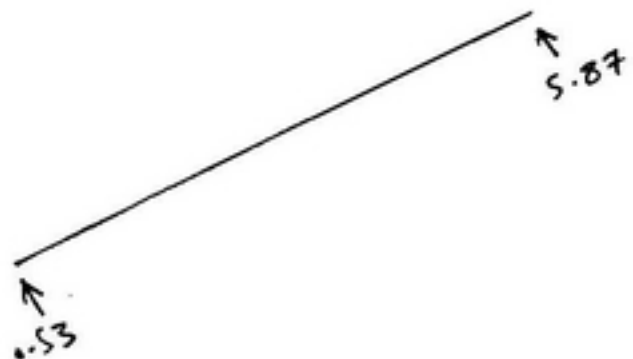
$$\sin \theta = 0.6$$



Normal

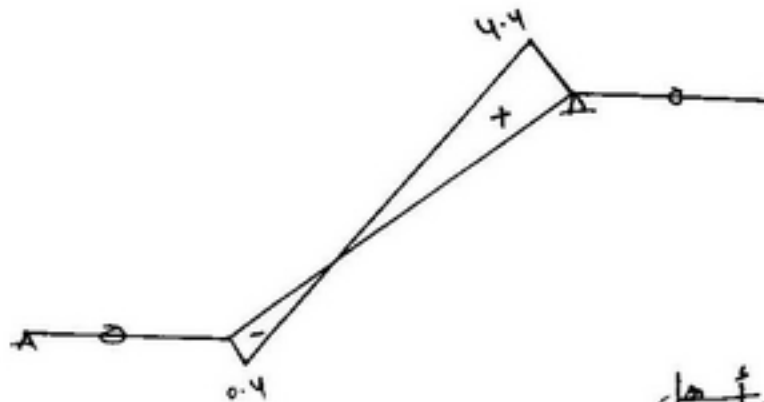


Shear

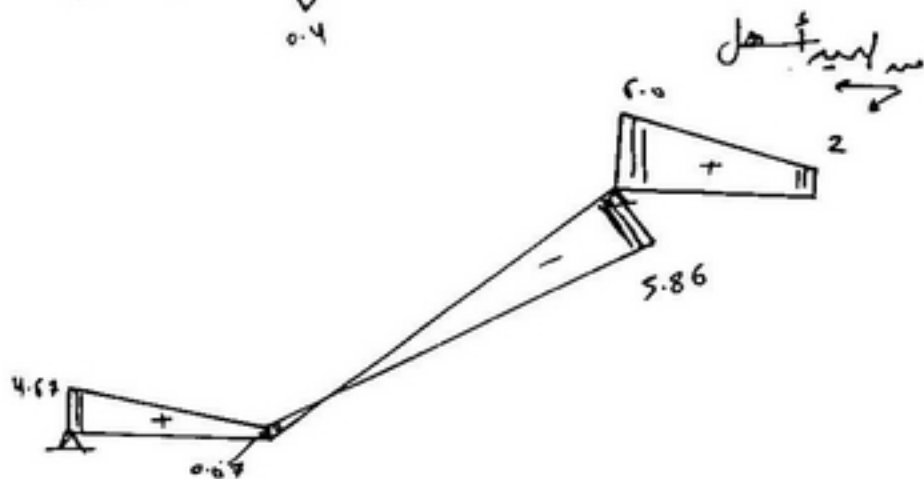


drawings

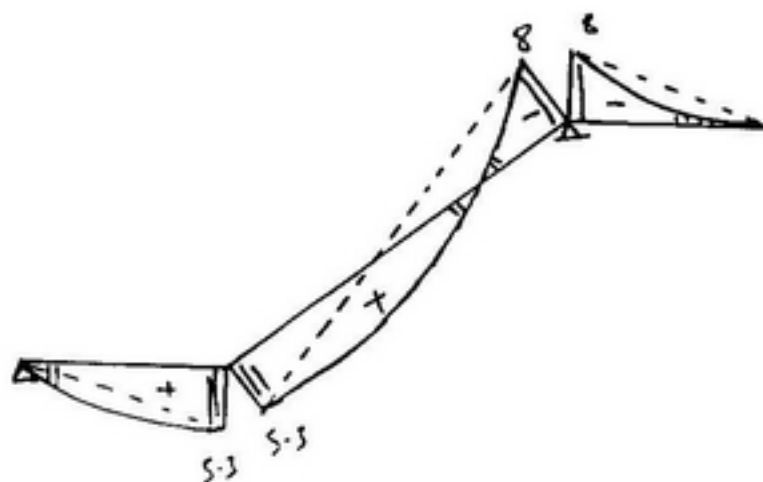
N.F.D



S.F.D

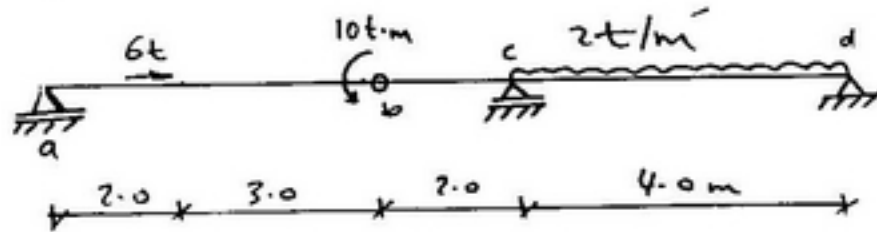


B.M.D



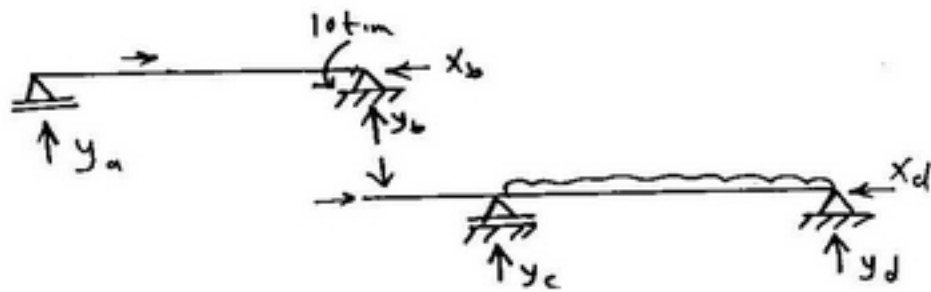


2



draw N.F.D , S.F.D , B.M.D

————— sol —————

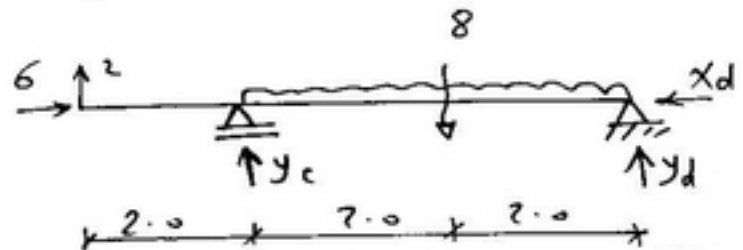


Part a - b

$$\begin{aligned}
 & \times \sum X = 0.0 \\
 & \quad X_b = 6 \text{ ton} \leftarrow \\
 & * \sum M_b = 0.0 \\
 & \Rightarrow 10 = y_a * 5 \\
 & \quad y_a = 2 \text{ ton} \uparrow \\
 & \times \sum y = 0.0 \\
 & \quad y_b = 2 \text{ ton} \downarrow
 \end{aligned}$$

4

Part b d



$$\Rightarrow \sum X = 0$$

$$\therefore X_d = 6 \text{ ton} \leftarrow$$

$$\Rightarrow \sum M_d = 0$$

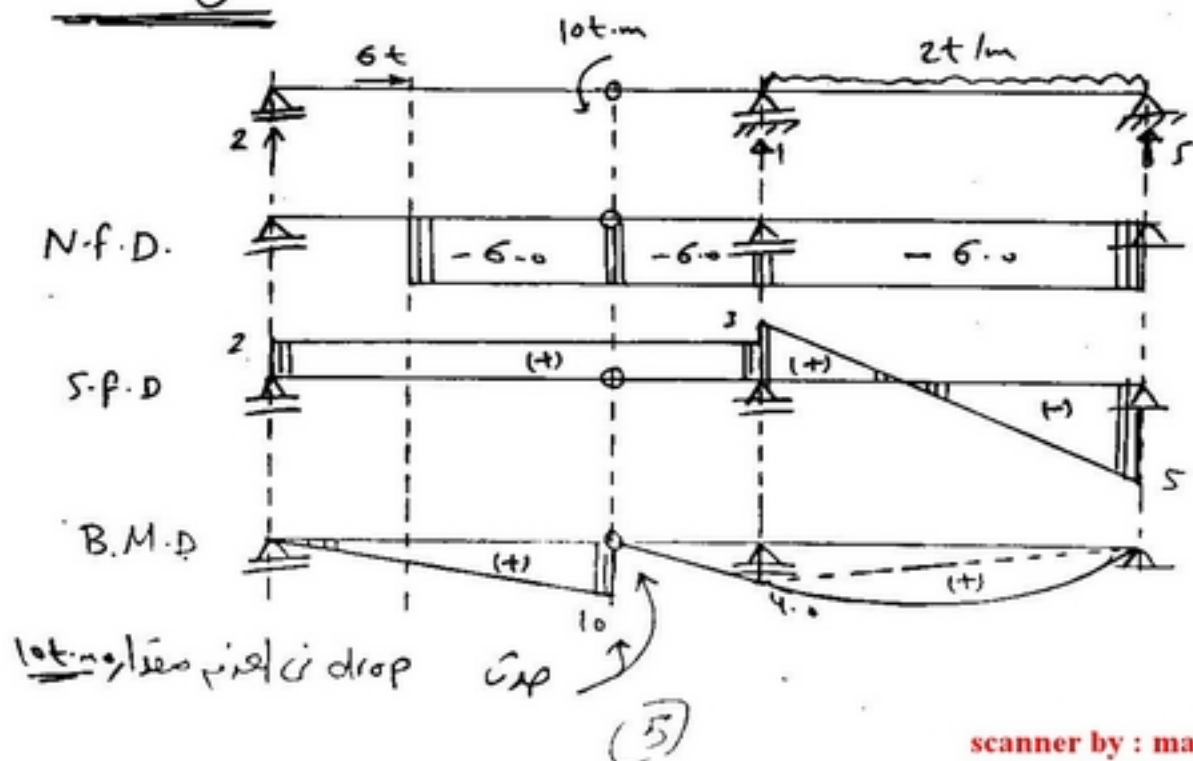
$$8 \times 2 = Y_c \times 4 + 2 \times 6$$

$$Y_c = 1 \text{ ton} \uparrow$$

$$\Rightarrow \sum Y = 0$$

$$\therefore Y_d = 5 \text{ t} \uparrow$$

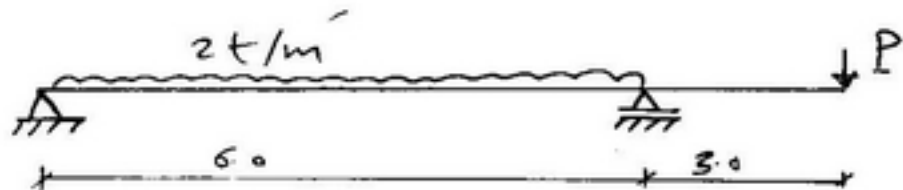
drawings



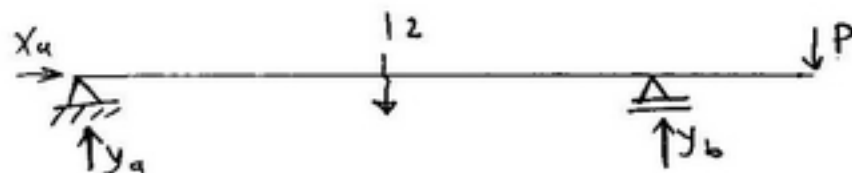
7

find the value of  $P$  which make

$$\max (+ve) B.M = \max (-ve) B.M$$



— Sol —



Reactions

$$\sum X = 0.0$$

$$\Rightarrow X_a = 0.0$$

$$\sum M_a = 0.0$$

$$\Rightarrow 12 \times 3 + P \times 9 = Y_b \times 6$$

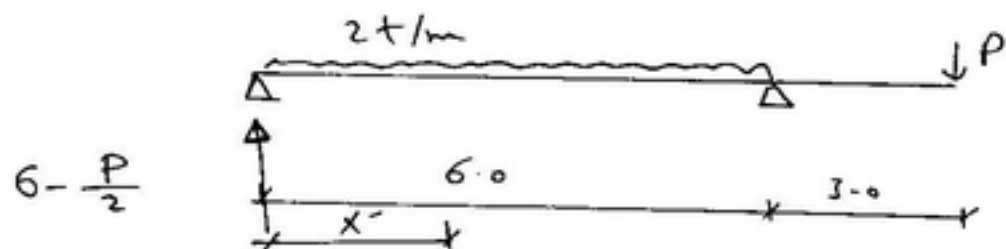
$$\Rightarrow Y_b = 6 + 1.5P$$

$$\sum Y = 0.0$$

$$\Rightarrow 12 + P = 6 + 1.5P + Y_a$$

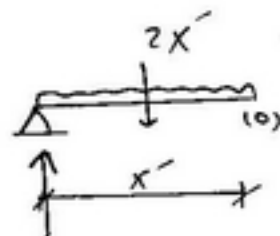
$$\boxed{Y_a = 6 - 0.5P}$$

## Position of Zero Shear



$$Q_o = 0 = (6 - \frac{P}{2}) - 2x'$$

$$x' = 3 - \frac{P}{4}$$



$$M_o = (6 - \frac{P}{2})x' - 2x' \frac{x'}{2} (6 - \frac{P}{2})$$

$$= (6 - \frac{P}{2})(3 - \frac{P}{4}) - (3 - \frac{P}{4})^2$$

$$= 18 - 1.5P - 1.5P + \frac{P^2}{8} - [9 - 1.5P + \frac{P^2}{16}]$$

$$M_{\text{Max (+ve)}} = 9 - 1.5P + \frac{P^2}{16}$$

$$M_{\text{Max (-ve)}} \text{ at } b = P \times 3$$

$$\therefore M_{+ve} = M_{-ve}$$

$$9 - 1.5P + \frac{P^2}{16} = 3P$$

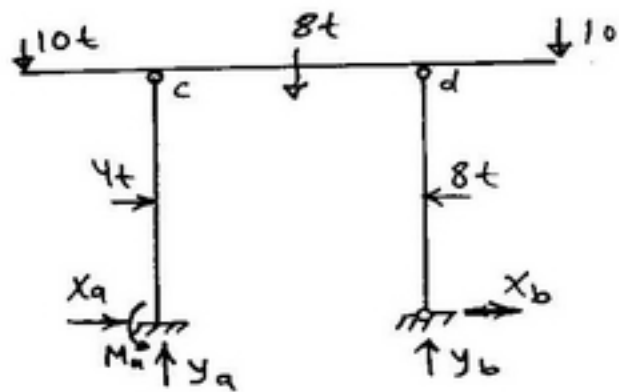
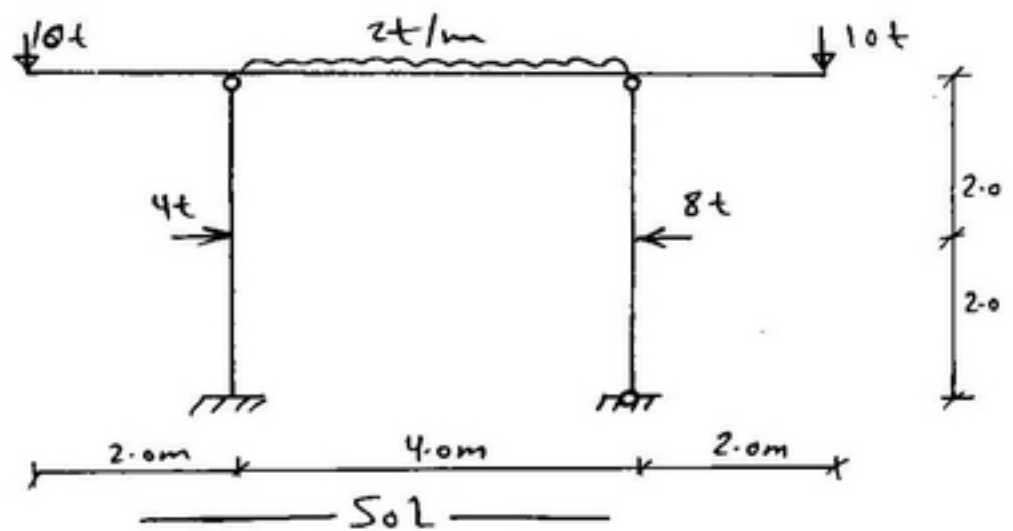
$$\therefore P^2 - 72P + 144 = 0$$

$$\Rightarrow P = 2.06 \text{ ton}$$

OK

$$\therefore \bar{X} = 3 - \frac{2.06}{4} = 2.485$$

4] For the following frame draw  
N.f.D, s.f.D & B.M.D



$$\ast \underline{\underline{\sum M_d = 0.0}}$$

$$8 \times 2 = X_b \times 4$$

$$\Rightarrow X_b = 4 \text{ ton}$$

9

$$\Rightarrow \underline{\sum X = 0.0}$$

$$\therefore X_a + 4 + 4 = 8$$

$$\therefore X_a = 0.0$$

$$\Rightarrow \sum M_a = 0.0$$

$$0.0 = 4 \times 2 + 8 \times 2 + 10 \times 6 - 8 \times 2 - 10 \times 2 - M_a - Y_b \times 4$$

$$M_a + 4Y_b = 48 \longrightarrow \textcircled{1}$$

$$\Rightarrow \sum M_{C_{down}} = 0.0$$

$$4 \times 2 + M_a + \underbrace{X_a \times 4}_{=0.0} = 0.0$$

$$M_a = -8 \text{ t.m}$$

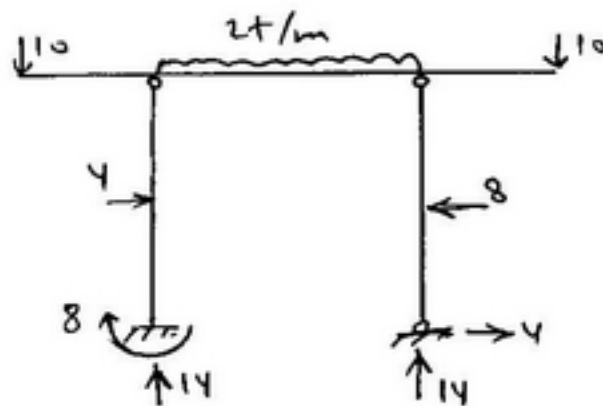
$$\therefore -8 + 4Y_b = 48$$

$$Y_b = 14 \text{ ton}$$

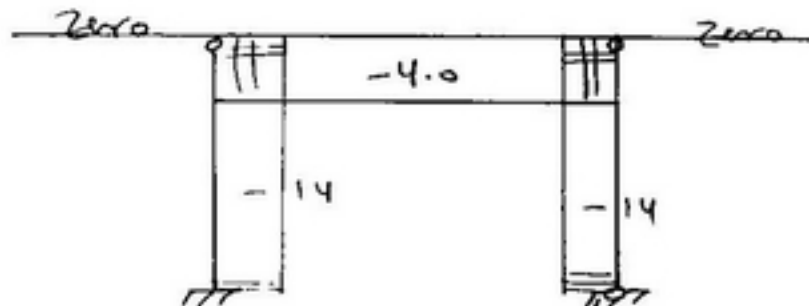
$$\sum Y = 0.0 \Rightarrow 10 + 8 + 10 - 14 = Y_a$$

$$Y_a = 14 \text{ ton}$$

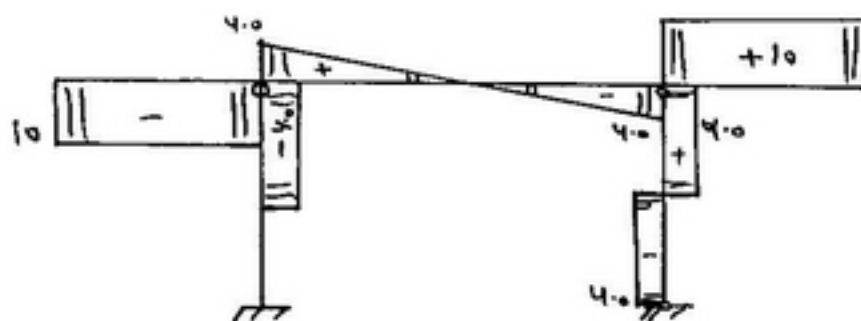
(10)



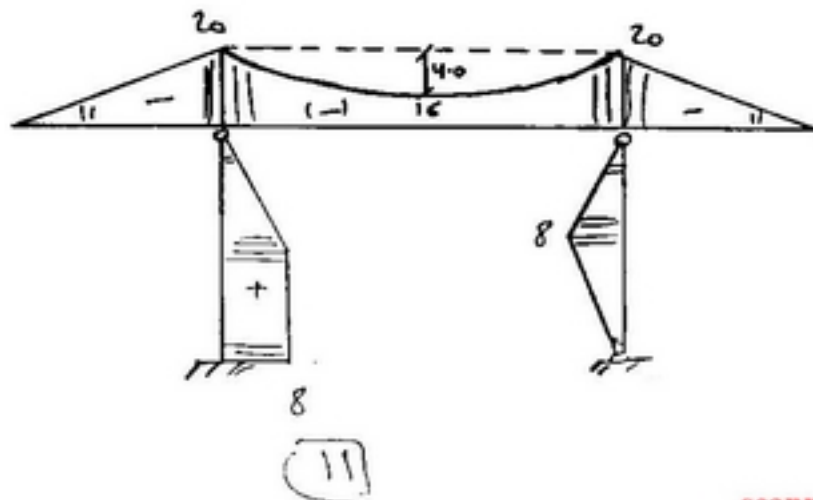
N-f-D



S.F.D

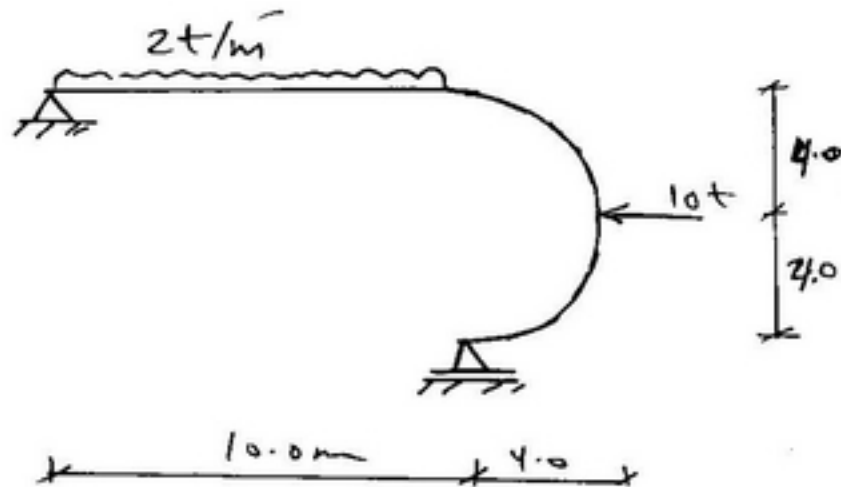


B.M.D



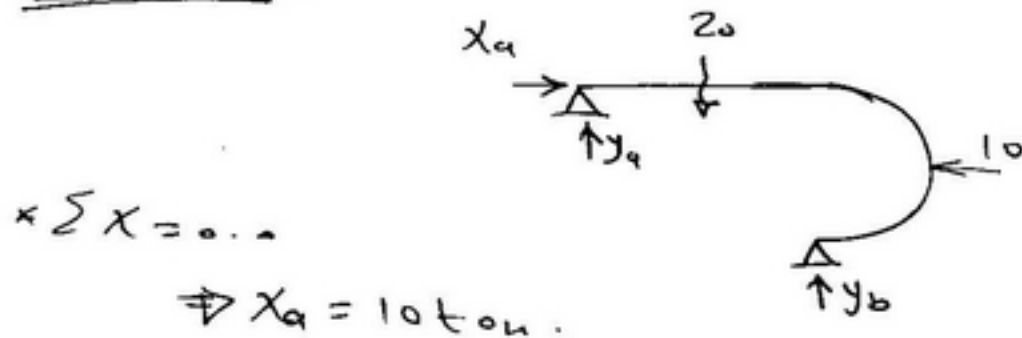


6] For the following Arch draw  
S.F.D, N.F.D & B.M.D



— Sol —

Reactions



$$\sum X = 0 \dots$$

$$\Rightarrow X_a = 10 \text{ ton.}$$

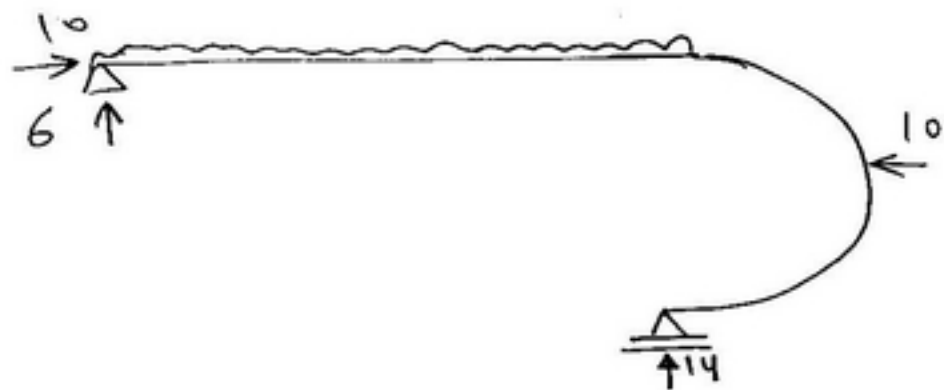
$$\sum M_a = 0 \dots$$

$$20 \times 5 + 10 \times 4 = Y_b \times 10$$

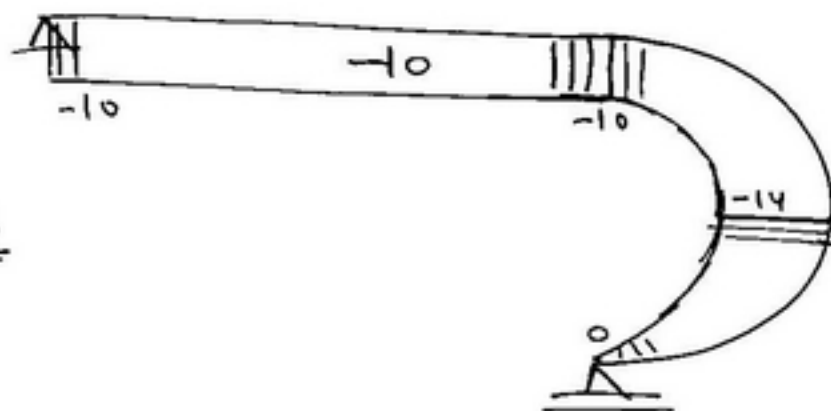
$$Y_b = 14 \text{ ton}$$

$$\sum Y = 0 \dots \Rightarrow Y_a = 6 \text{ ton.}$$

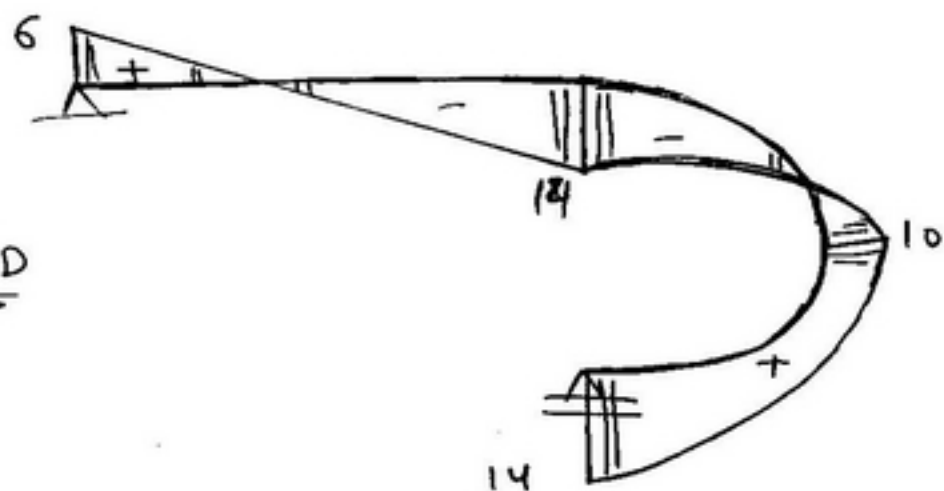
(12)



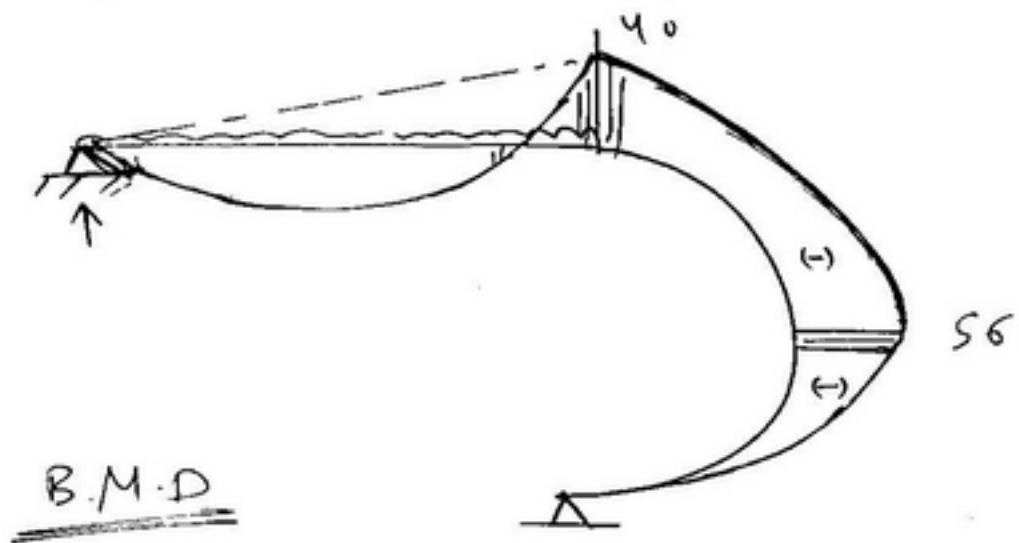
N.F.D



S.F.D

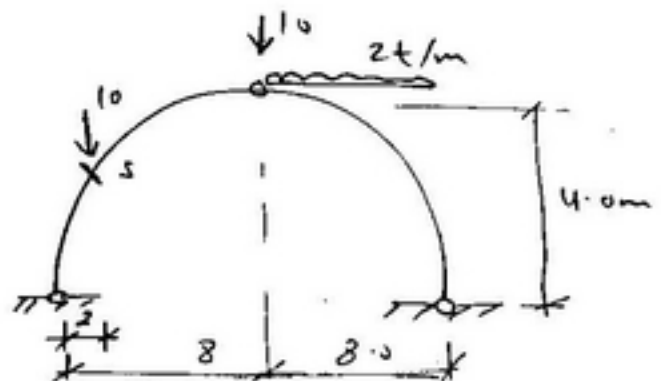


(13)



[7] for the following Circular Arch

find N.F, S.F, B.M at section S



— Sol —

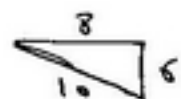
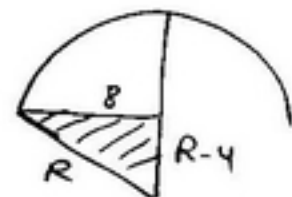
Finding R

$$R^2 = 8^2 + (R-4)^2$$

$$= 64 + R^2 - 8R + 16$$

$$\therefore 8R = 80 \Rightarrow R = 10 \text{ m.}$$

$$\therefore R - h = 6.0 \text{ m}$$

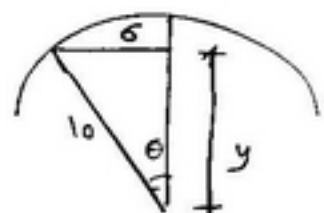


find h & \theta

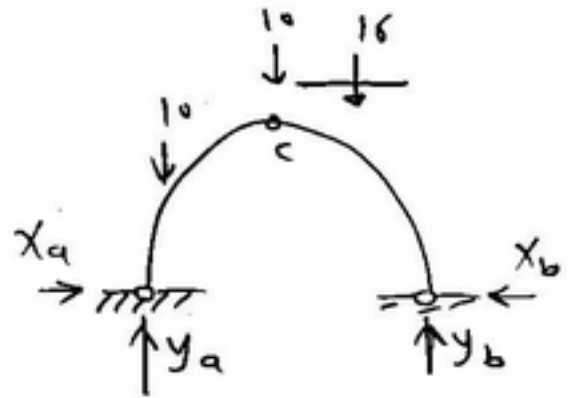
$$\therefore y = 8 \text{ m} \Rightarrow h = 2 \text{ m}$$

$$\theta = \sin^{-1} 0.6 = 36.86^\circ$$

(15)



## Finding Reaction



$$\sum M_A = 0 \Rightarrow$$

$$\Rightarrow 10 \times 2 + 10 \times 8 + 16 \times 12 = Y_B \times 16$$
$$\Rightarrow Y_B = 18.25 \text{ ton}$$

$$\sum Y = 0 \Rightarrow Y_A = 17.75$$

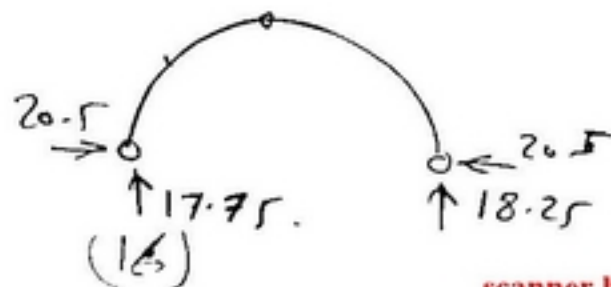
$$\sum M_C = 0 \Rightarrow$$

$$10 \times 6 + X_A \times 4 = 17.75 \times 8$$

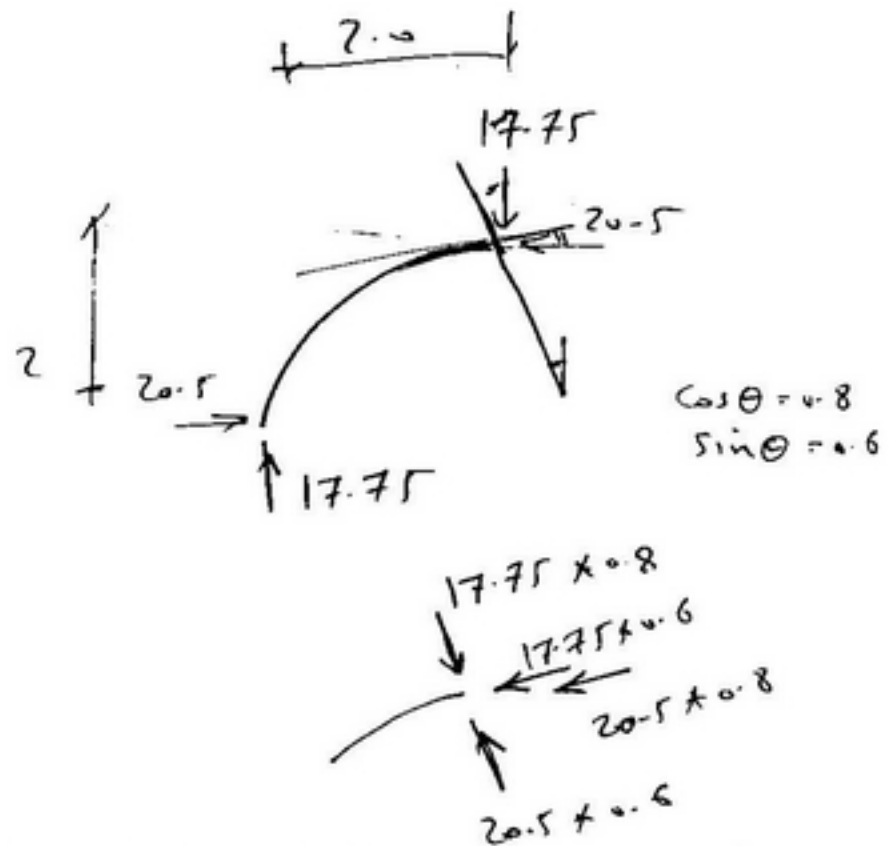
$$X_A = 20.5 \text{ ton}$$

$$\sum X = 0 \Rightarrow$$

$$\Rightarrow X_B = 20.5 \text{ ton}$$



at section



$$N.f = - (17.75 \times 0.6 + 20.5 \times 0.8)$$

$$= -27.05 \text{ ton}$$

$$S.f = 17.75 \times 0.8 - 20.5 \times 0.6 = +1.9 \text{ ton}$$

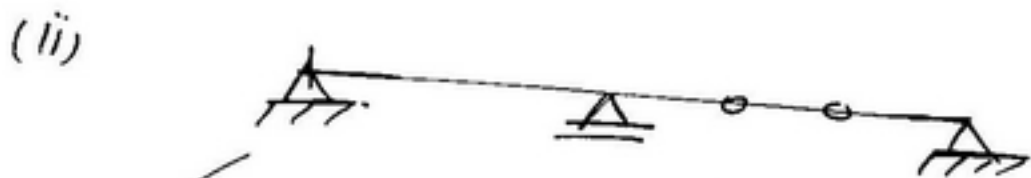
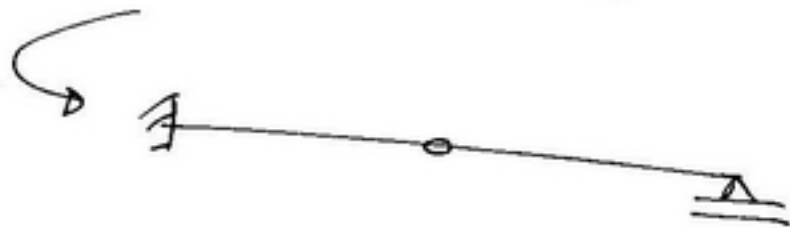
$$B.M = +17.75 \times 2 - 20.5 \times 2$$

$$= -5.5 \text{ t.m}$$

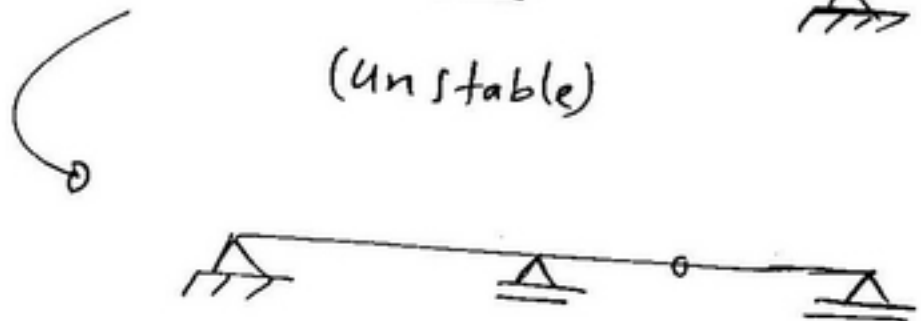
8] for the following beam define it to be  
 Stable or not & determinate or not  
 and make it stable & determinate



(unstable)

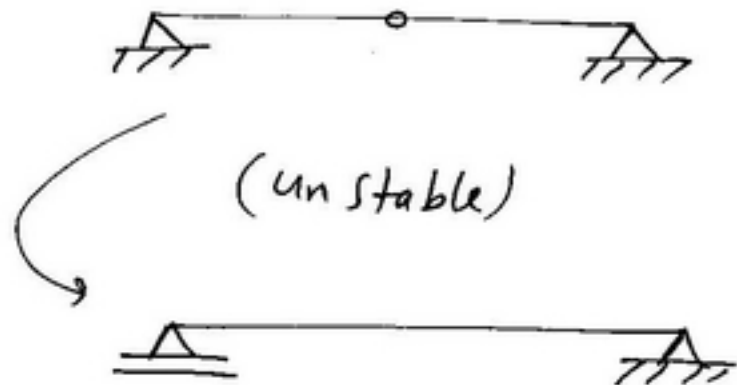


(unstable)

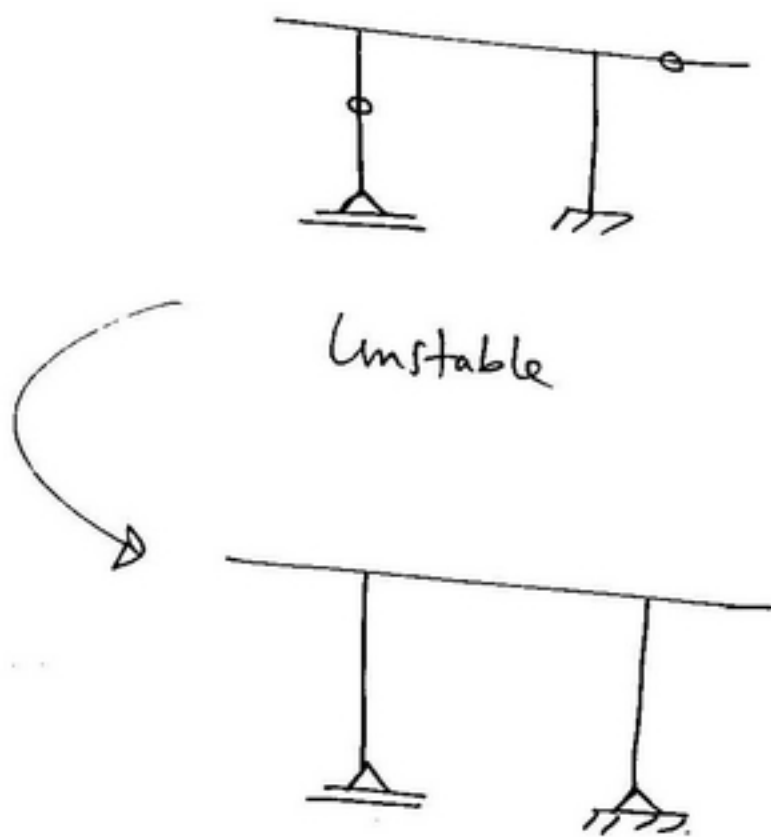


(ix) Stable & determinate

(iv)



(v)





بسم الله الرحمن الرحيم

# Truss

المجال

\* تحليل Truss يعني ايجاد القوى الداخلية (وهي بار و Normal force) فقط .  
فقط عناصر Truss لا تأمل أي نوع من العناصر (لا قوى ضغط)

\* يعتبر كل عنصر من Truss وهو عبارة عن link member

\* لا يأخذ القوى من Truss يوجد بعض العناصر معلومة القيمة صفر  
ويسمى هذا العنصر (zero member) وكذا معرفة يقع في الزاوية  
من Truss ونستخدم لتسهيل إنشاء

\* حالات Zero member

① مفردية كل ما يستقامه واحدة  
وتخرج تلك منها ولا يوجد قوى عند هذه joint



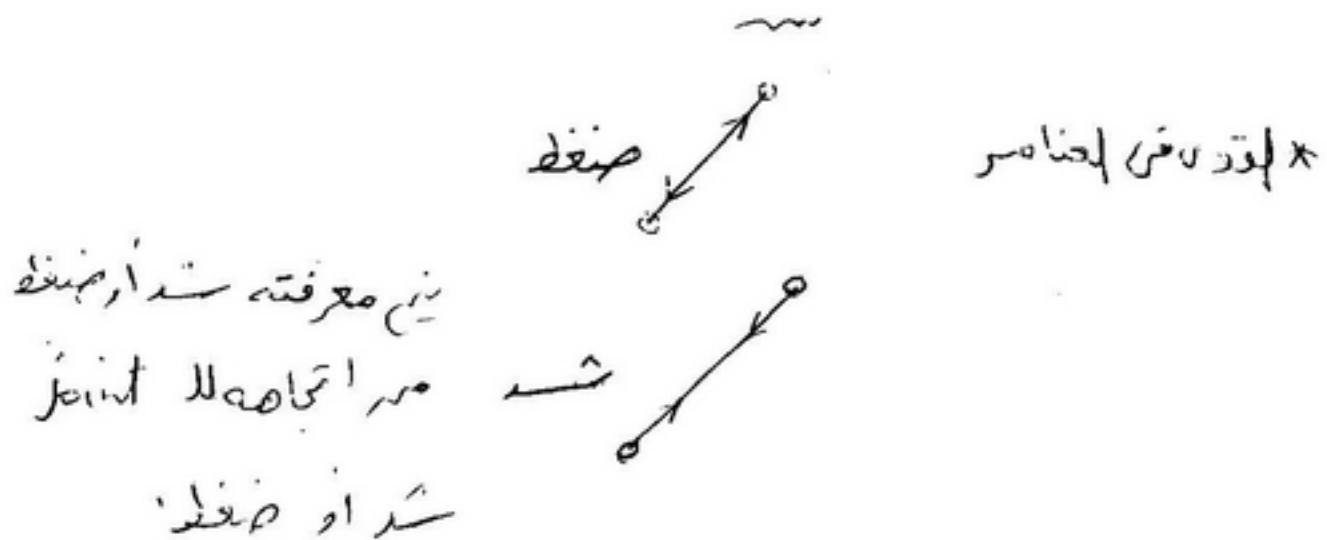
② مفردية مشتركة في نفس joint ولا يوجد تأثير في الخوا





\* member A  $\rightarrow$  zero member.

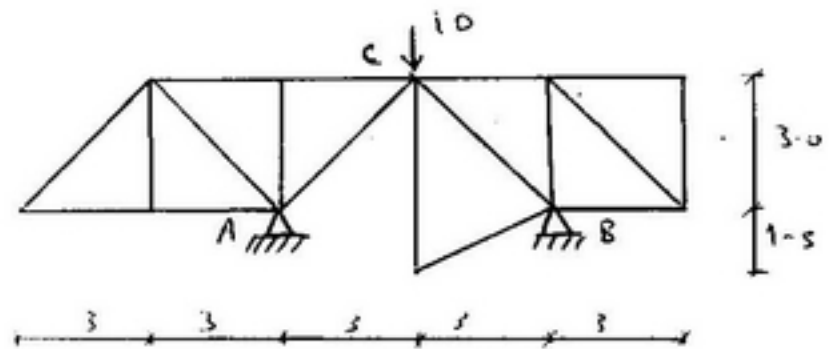
\* member B  $\rightarrow$  با فرایند کامل



\* کند، وجود joint خالصه لنه تغییرات intermediate

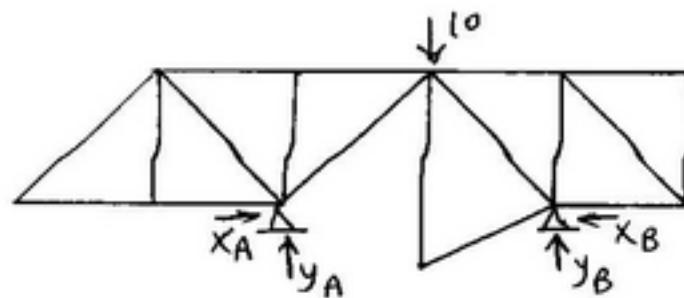


final 99



find the forces in all member.  
for the following

— SOL —



$$* \sum M_A = 0$$

$$10 \times 3 - Y_B \times 6 = 0$$

$$\therefore Y_B = 5 \text{ t}$$

$$* \sum M_{C_R} = 0$$

$$X_B \times 3 - Y_B \times 3 = 0$$

$$\Rightarrow X_B = 5 \text{ t}$$

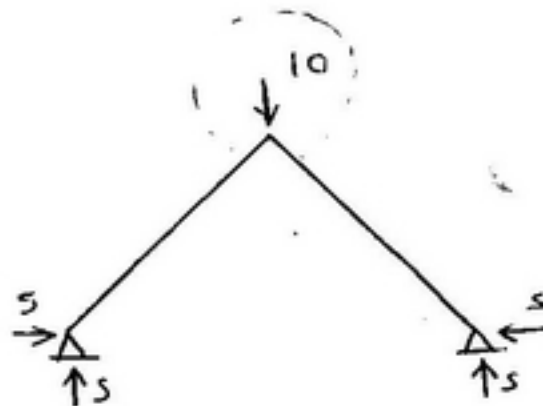
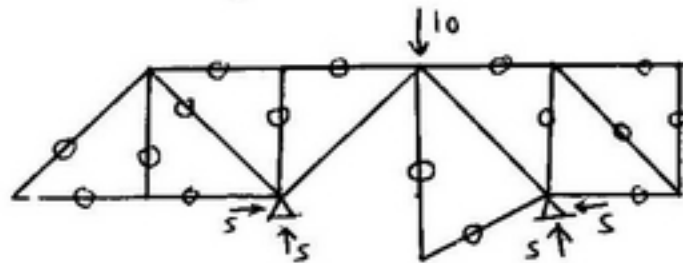
(3)

$$* \sum Y = 0.0$$

$$\Rightarrow Y_A = 10 - 5 = 5 \text{ ton}$$

$$* \sum X = 0.0$$

$$\Rightarrow X_A = 5 \text{ t}$$



مركز كل مفصلية

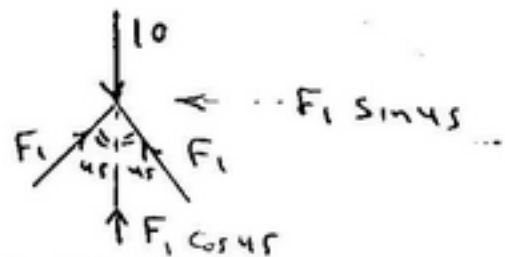
$$\sum X = 0 \Rightarrow$$

$$\sum Y = 0 \Rightarrow$$

$$* \sum X = 0.0$$

$$F_1 \sin 45 = F_2 \sin 45$$

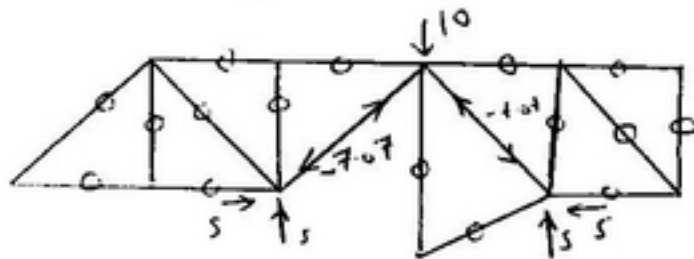
$$\therefore F_1 = F_2 = F$$



$$\sum Y = 0$$

$$\therefore 2 F \cos 45 = 10$$

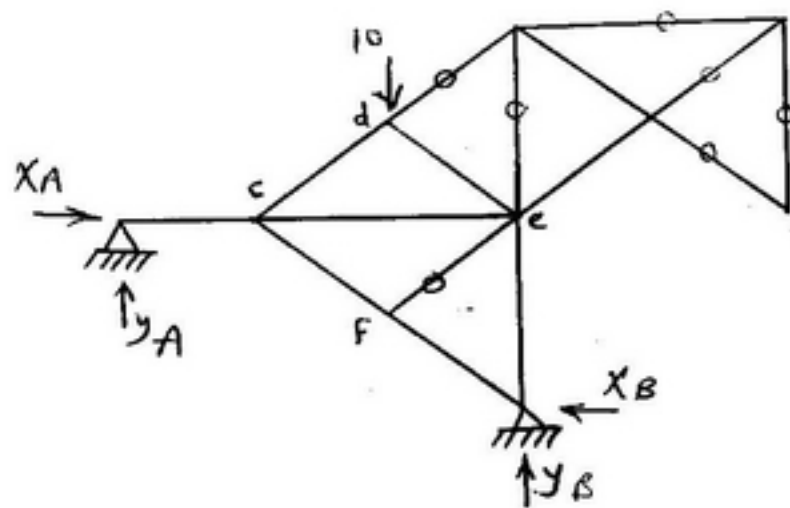
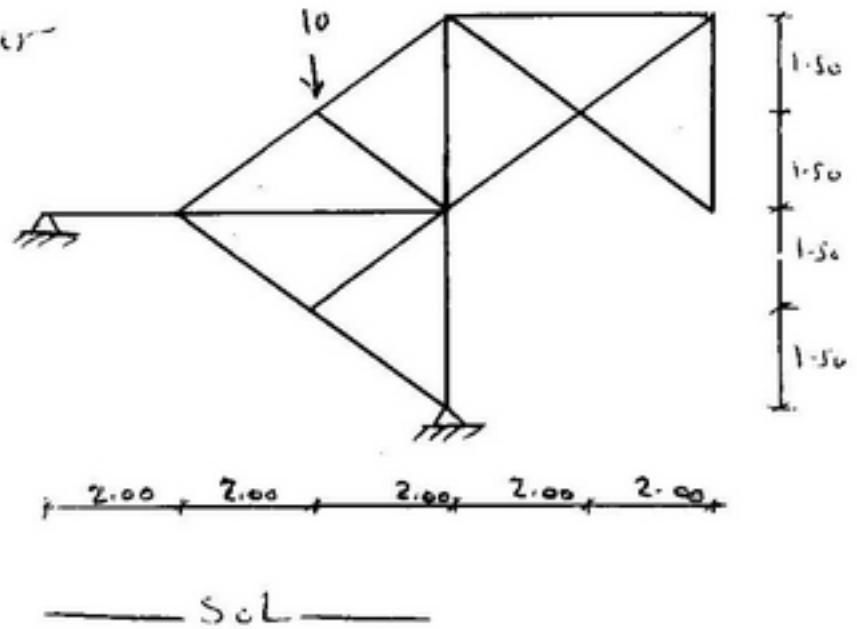
$$\therefore F = 7.07 \text{ kN}$$



all forces.

Final 2010

find all member  
force.



(6)

### Reactions

$$\ast \sum M_{CL} = Y_A \ast 2 = 0.0$$

$$\Rightarrow Y_A = 0.0$$

$$\ast \sum Y = 0.0$$

$$\Rightarrow Y_B = 10 \text{ t} \uparrow$$

$$\ast \sum M_A = 0.0$$

$$\Rightarrow 10 \ast 4 - 10 \ast 6 + X_B \ast 3 = 0.0$$

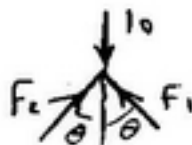
$$X_B = 6.66 \text{ t} \leftarrow$$

$$\ast \sum X = 0.0$$

$$\Rightarrow X_A = 6.66 \text{ t} \rightarrow$$

### Forces

(joint(d))



$$\sum X = 0.0$$

$$F_1 \sin \theta = F_2 \sin \theta$$

$$\Rightarrow F_1 = F_2 = F$$

$$\Sigma y = 0.0$$

$$2 \cdot F \cos \theta = 10$$

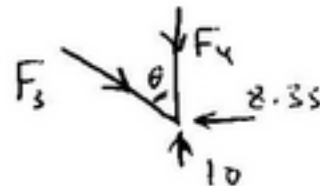
$$F = \frac{10}{2 \times 0.6} = 8.33 \text{ ton}$$

(joint (b))

$$\Sigma X = 0.0$$

$$F_3 \sin \theta = 8.33$$

$$F_3 = \frac{8.33}{0.8} = 10.4$$



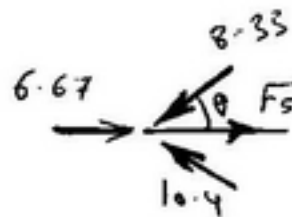
$$\Sigma y = 0.0$$

$$F_4 + 10.4 \cos \theta = 10$$

$$F_4 = 10 - 10.4 \times 0.6 = 3.64$$



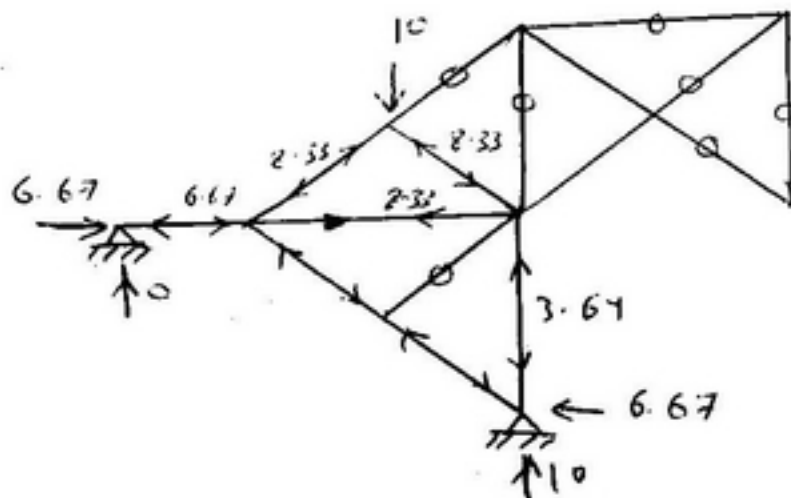
joint (c)



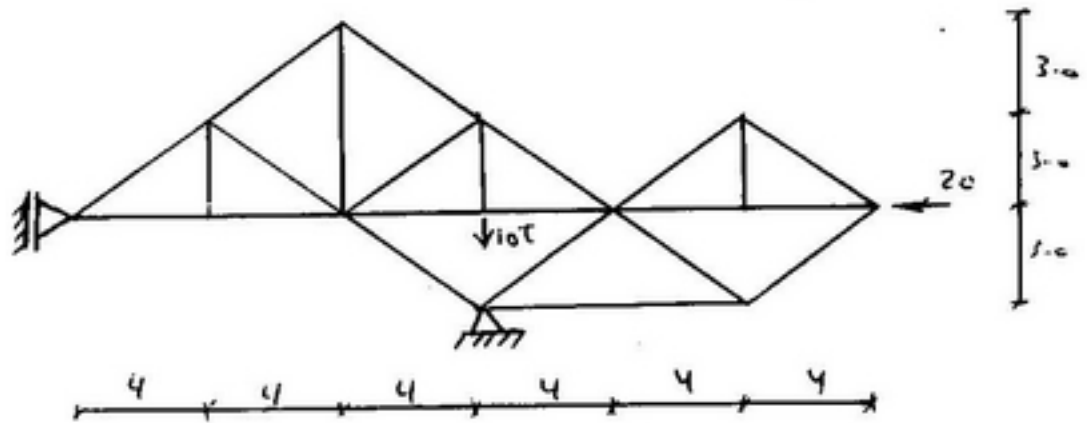
$$\sum X = 0.0$$

$$\begin{aligned} 6.66 + F_s &= 8.33 \cos \theta + 10.4 \cos \theta \\ &= 8.33 \times 0.8 + 10.4 \times 0.8 \end{aligned}$$

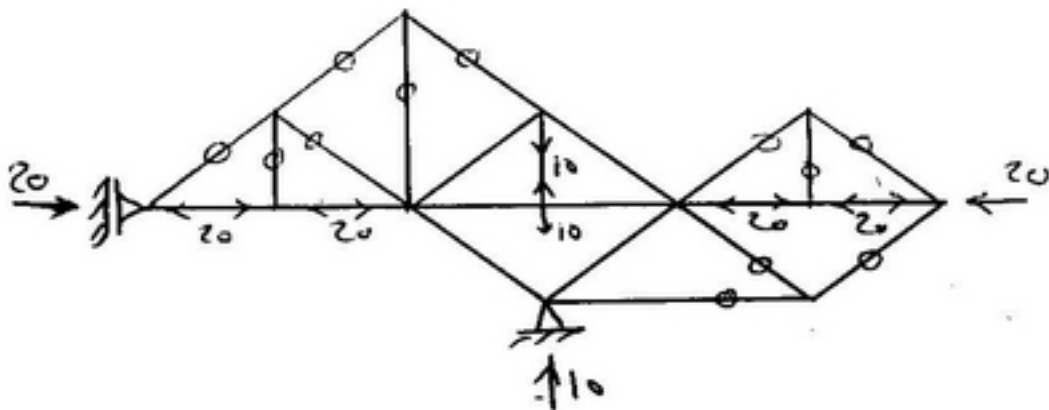
$$\begin{aligned} F_s &= 15 \text{ ton} - 6.67 \\ &= 8.33 \end{aligned}$$



Final 2002



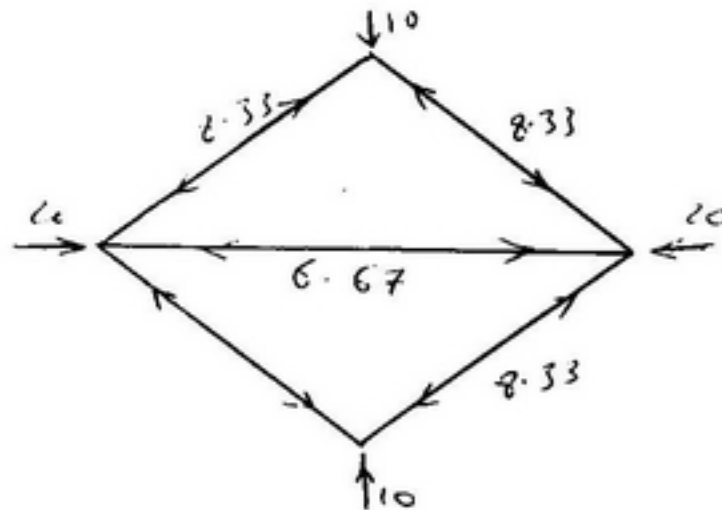
———— Sol ————



لا ضل عندنا يكونه كضرا

كل استقامه واداءه و آتو كينها

و براجو قو بتا ضرها  $\frac{10}{11}$



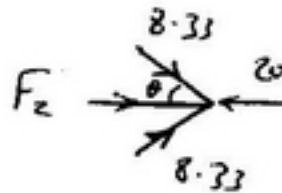
$$2F \cos \theta = 10$$

$$F = \frac{10}{2 \times 0.6} = 8.33$$

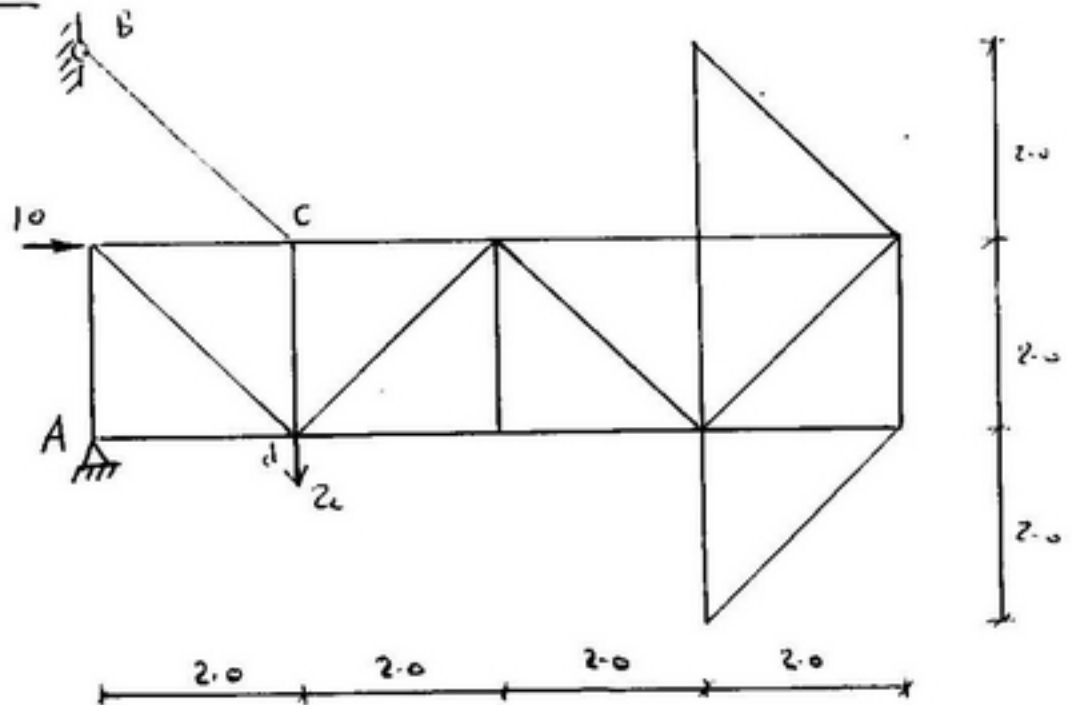


$$20 = 2 \times 8.33 \times 0.8 + F_2$$

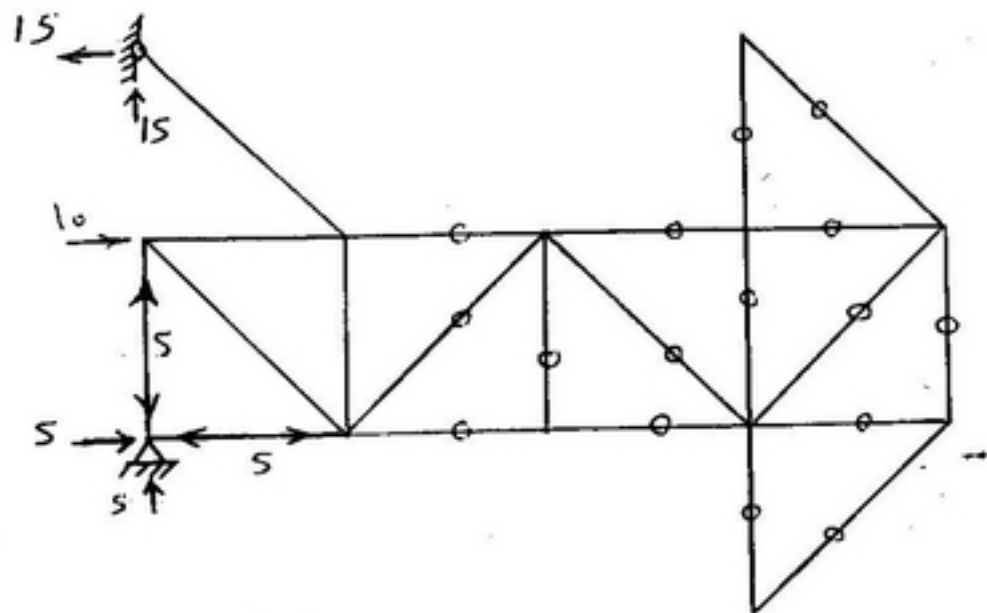
$$F_2 = 6.67$$



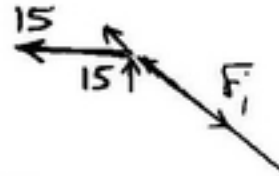
Final 2004



— SOL —

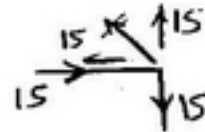


at B

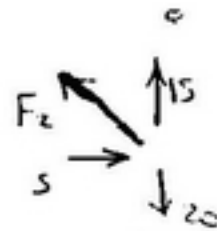


$$F_1 = 15 * \cos 45 * 2 =$$

at C

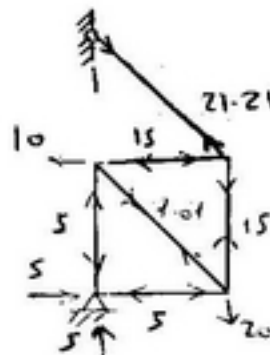


at D



$$S = F_2 \cos 45$$

$$F_2 = 7.07$$

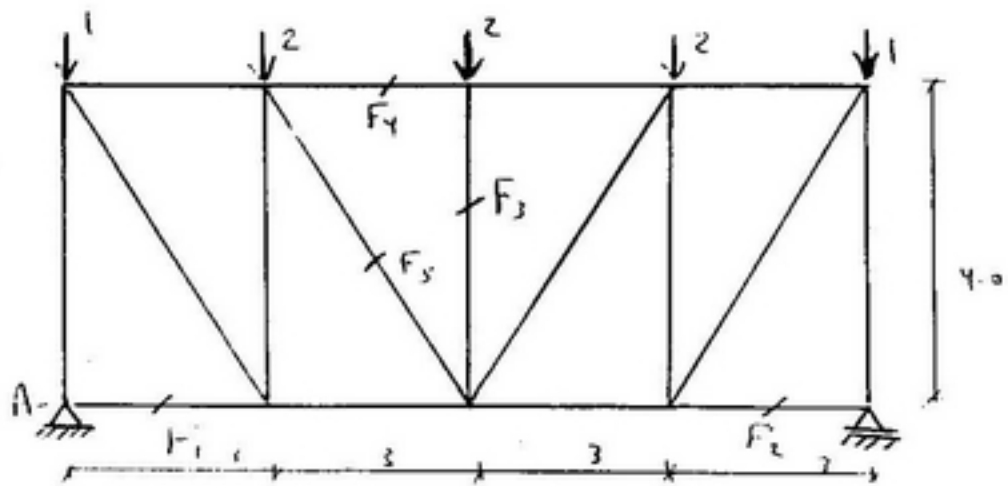


\* لاحظ الطريقة التي تم استخدامها هي طريقة الأتزان joint

\* هناك طريقة أخرى هي method of section

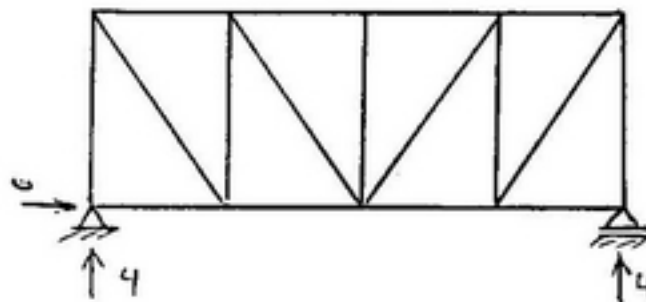
تستخدم هذه الطريقة عندما يكون هناك قوى داخلية ولإيجادها  
لوقت يتم عمل مقاطعات

Example



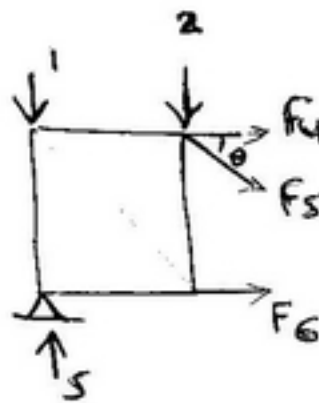
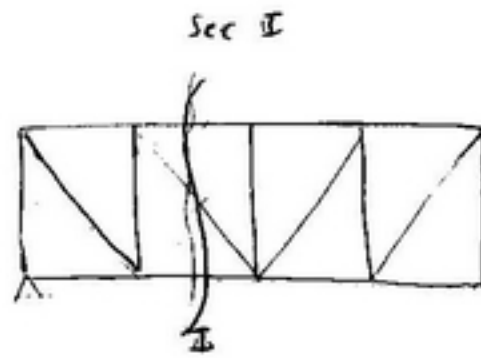
Required  $F_1, F_2, F_3, F_4, F_5$

SOL



$$F_1 = F_2 = 0.0$$

$$F_3 = -2 \text{ ton}$$



$$\sum y = 0.0$$

$$\therefore F_5 \sin \theta = 5 - 3$$

$$F_5 = 2.5 \text{ t}$$

$$\sum M_A = 0.0$$

$$2 \times 3 + 2.0 \times 5 + F_4 \times 4 = 0.0$$

$$\Rightarrow F_4 = -3$$

$$\sum x = 0.0$$

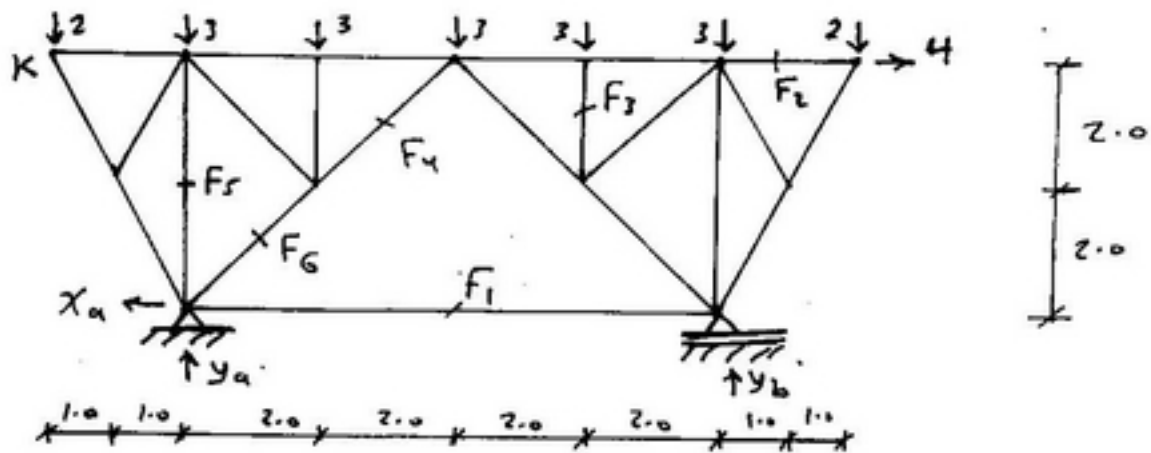
$$3 - 2.5 \times 0.5 + F_6 = 0.0$$

$$F_6 = 1.5$$

$$\frac{6x}{7}$$



Final 2004



— Sol —

Reaction

$$\sum X = 0.0$$

$$X_a = 4 \text{ ton}$$

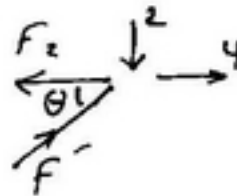
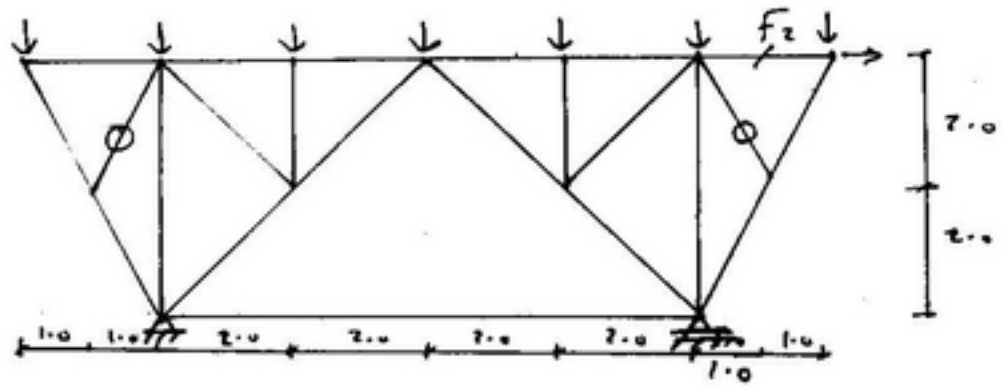
$$\sum M_a = 0.0$$

$$-Y_b \times 8 - 2 \times 2 + 3 \times 2 + 3 \times 4 + 3 \times 6 + 3 \times 8 + 2 \times 10 + 4 \times 4 = 0.0$$

$$Y_b = 11.5 \text{ ton}$$

$$\sum Y = 0.0$$

$$Y_a = 7.5 \text{ ton}$$



$$\rightarrow \Sigma y = 0$$

$$F' \times \sin \theta = 2$$

$$\Rightarrow F' = \frac{2}{0.894} = 2.237 \text{ ton.}$$

$$\theta = \tan^{-1} \left( \frac{4}{2} \right)$$

$$= 63.43^\circ$$

$$\sin \theta = 0.894$$

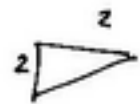
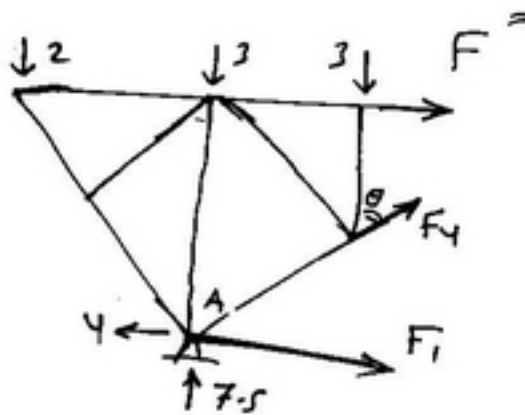
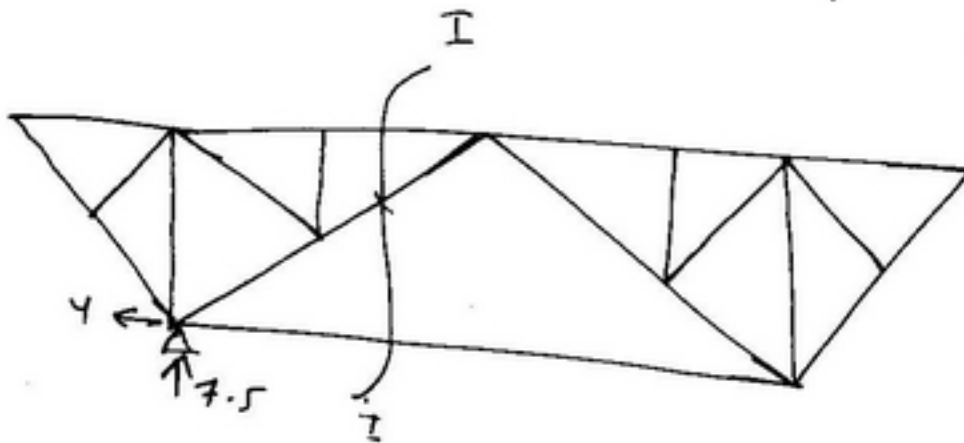
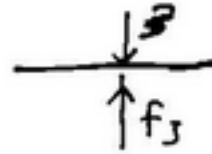
$$\cos \theta = 0.447$$

$$\rightarrow \Sigma x = 0$$

$$4 + 2.237 \times 0.447 = F_2$$

$$\Rightarrow F_2 = 5 \text{ ton}$$

$$F_3 = 3 \text{ ton}$$



$$\theta = 45^\circ$$

$$\underline{\underline{\sum y = 0}}$$

$$2 + 3 + 3 = 7.5 + F_4 \cos \theta$$

$$\Rightarrow F_4 = 0.707 \text{ ton.}$$

$$\underline{\underline{\sum M_A = 0}}$$

$$3 \times 2 + F'' \times 4 = 2 \times 2$$

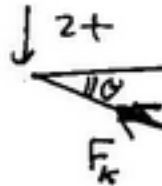
$$\Rightarrow F'' = -0.5 \text{ ton}$$

$$\sum X = 0$$

$$4 + 0.5 = F_1 + 0.707 (\sin 45)$$

$$F_1 = 4 \text{ ton}$$

joint K



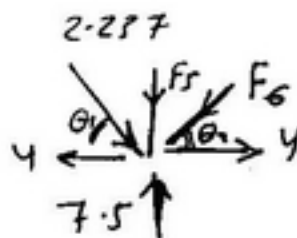
$$\sum Y = 0$$

$$2 = F_K \sin \theta$$

$$\Rightarrow F_K = 2.237$$

$$\theta = 63^\circ$$

joint A



$$\theta_1 = 63^\circ$$

$$\theta_2 = 45^\circ$$

$$\sum X = 0$$

$$4 - 2.237 \cos \theta_1 - 4 + F_6 \cos \theta_2 = 0$$

$$\Rightarrow F_6 = 1.141$$

$$\sum Y = 0$$

$$2.237 \sin 63 + F_5 + 1.141 \sin 45 = 7.5$$

$$\Rightarrow F_5 = 4.5 \text{ ton}$$

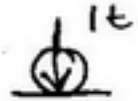
بسم الله الرحمن الرحيم

# Influence line

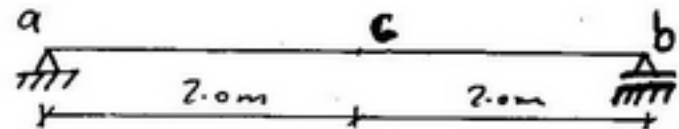
خطوط التأثير

\* هي دراسة تأثير حمل (1t) بمرور على كمره لا يوجد عليه أحمال على شكل اعزوم ولتقوى للوصول إلى أكثر قيمة يمكن تحقيقها عند الحمل

"For Beams"



Example ①



For the following beam

draw  $IL_{YA}$ ,  $IL_{Yb}$

$IL_{Mc}$ ,  $IL_{Mc}$

- Sol -

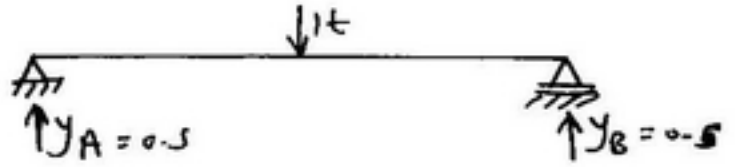
$IL_{YA}$

معنى رسم خط تأثير  $Y_A$  يعني انه نضع الحمل

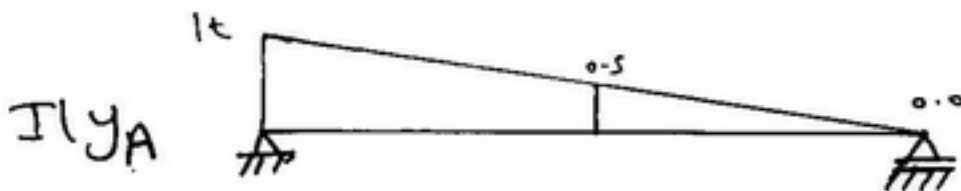
على مبرايه الكمره و نحسب قيمته (y) ثم نكرر الحيل

بأرتابه ط و نكرر حتى نحصل على قيمة (y) و رسم هذه القيمة

تم تزیین الی، دن کاره  
تم حساب  $y_A$ ,  $y_B$  نادر



تم سینه رفیع کره، سینه تعویج  
قیه  $y_A$  که نقطه تأثیر 1t  
ال کاره لکمر  $\Rightarrow \Leftarrow$



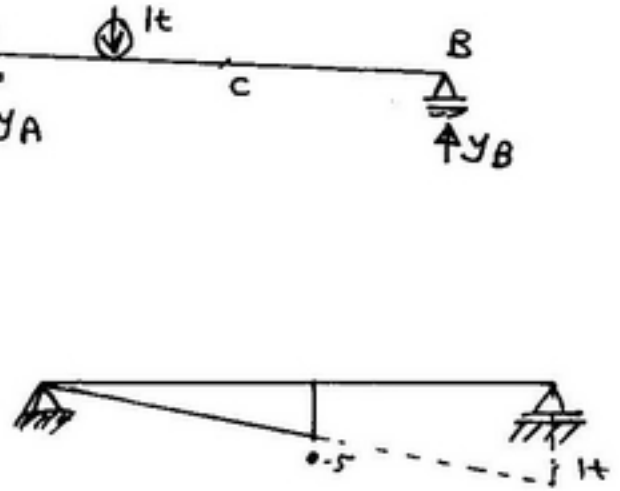
## ILQ

From A  $\rightarrow$  c

كندا يتحرك الحمل من A  $\leftarrow$  c  
 كندا حساب shear عند (C)  
 ليعمل افتد هام الحمل  $y_B \uparrow$

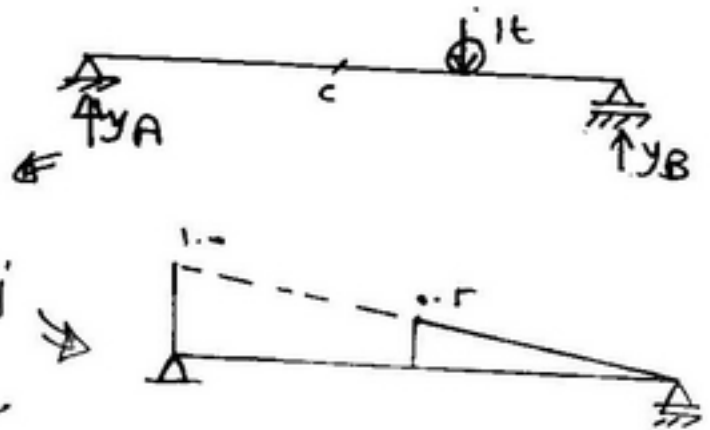
يبقى نازل

عينا نرسم IL  $y_B$  مقلوب رناقة  
 منو ليعمل ان يتحرك على اليمين  
 من A  $\leftarrow$  c

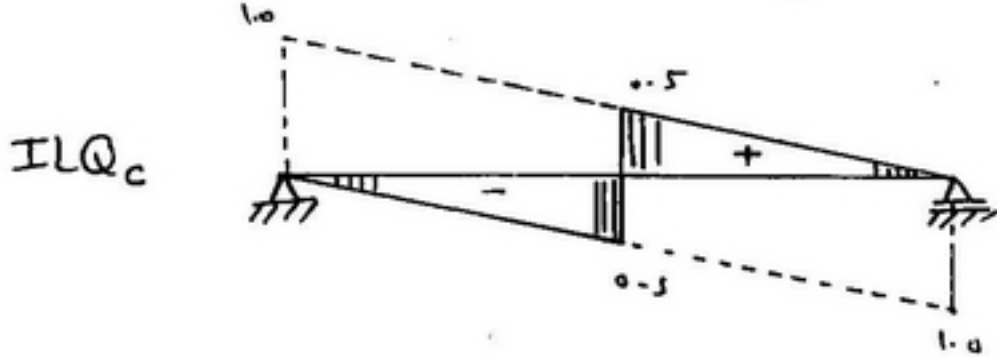


From c  $\rightarrow$  B

كندا يتحرك الحمل من c  $\rightarrow$  B  
 حساب shear من الحمل  
 أقل الحمل  $Q_c$   
 مقدار  $y_A \uparrow$



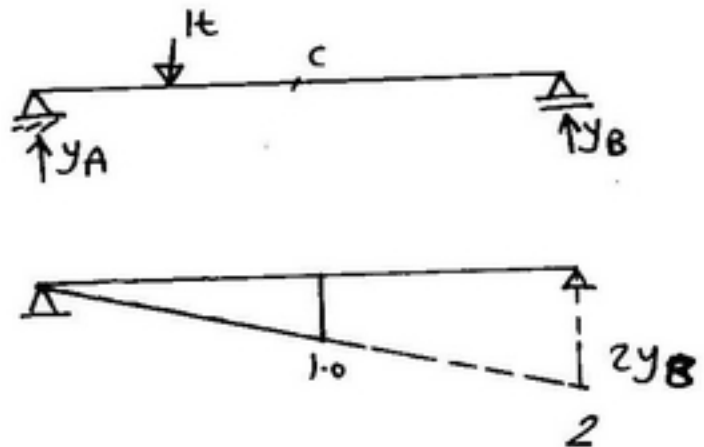
يتم تجميع استجابة للحمولة



ILM<sub>c</sub>

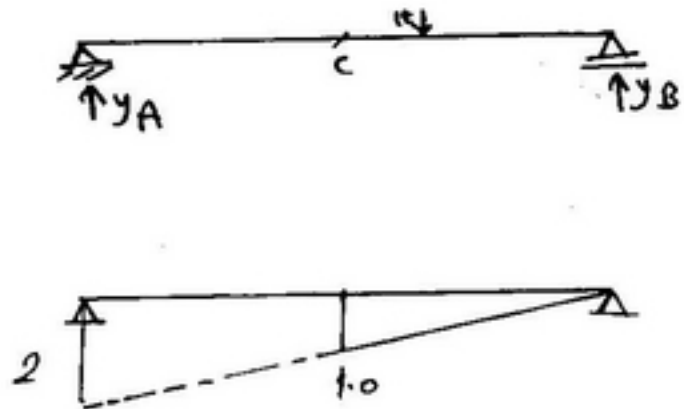
From A → C

كندا يتم ترك الحمل عند  
نقطة معينة لعدم عبث  
 $M_c = 2y_B$   
دليل الاستجابة



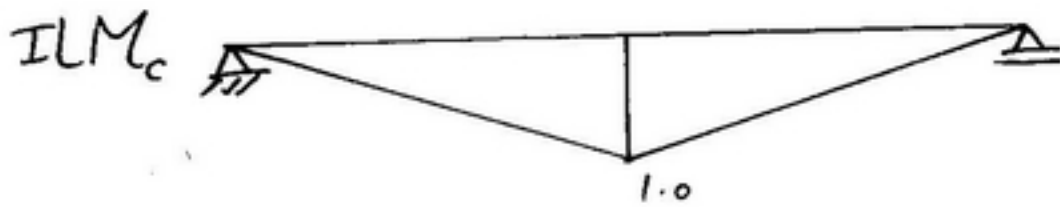
From C → B

كندا يتم ترك الحمل عند  
 $M_c = 2y_A$



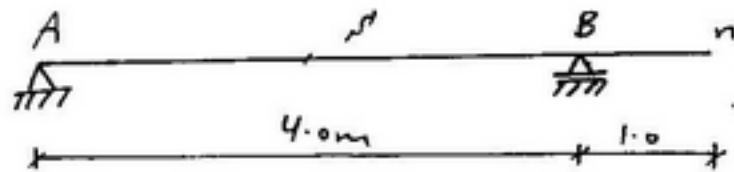


نتیجہ کشیدہ



کے لیے، اسے بائیں طرف سے  $\frac{P_{ab}}{L}$

## Example 2

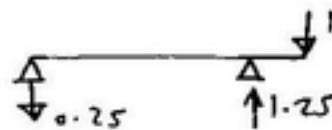


draw  $IL Y_A, Y_B, IL Q_S, ILM_S$   
 $IL M_B, IL Q_{BR}, IL Q_{BL}$

— Sol —

$IL Y_A$

From A  $\rightarrow$  B



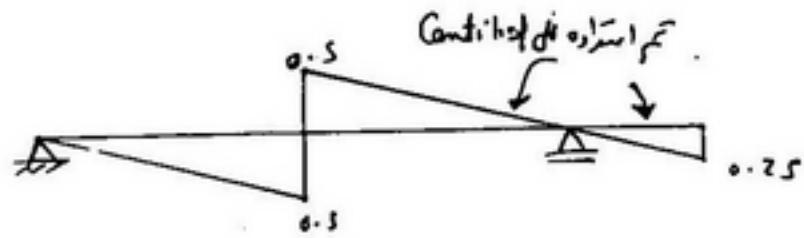
$Y_A = 0.25$  Reaction



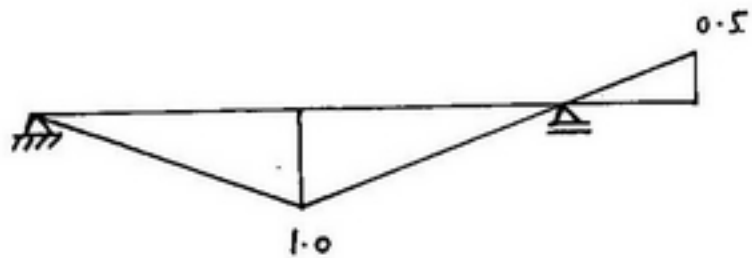
$Y_B = 1.25$

Reaction at B

IL Q<sub>s</sub>



IL M<sub>s</sub>



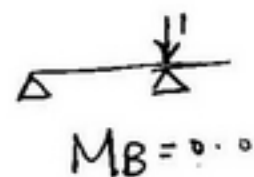
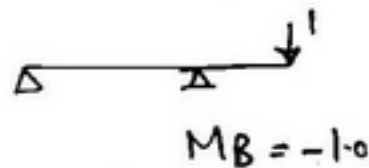
IL M<sub>B</sub>



\* عندما يتحرك الحمل من A → B فإنه طرأ لم يخرج الحمل من الدالة Cantilever

$$M_B = 0.0$$

نوعاً يتحرك الحمل من B → A فإنه يدخل الدالة Cantilever. نظرًا لعدم



ILM<sub>B</sub>



معنى هذا الشكل انه كل كذا يتحرك من A → B يكون قيمة M<sub>B</sub> = 0.0  
من كذا يتحرك من B → A يكون قيمة M<sub>B</sub> يتغير من 0.0 → 1.0

ILQ<sub>Br</sub>



أي انه يتركز في shear في cantilever

كذا يتحرك كل شيء في supports ← لا يتحرك في cantilever

كذا يتحرك كل شيء في cantilever ← لا يتحرك في supports

$$Q_{Br} = +1$$

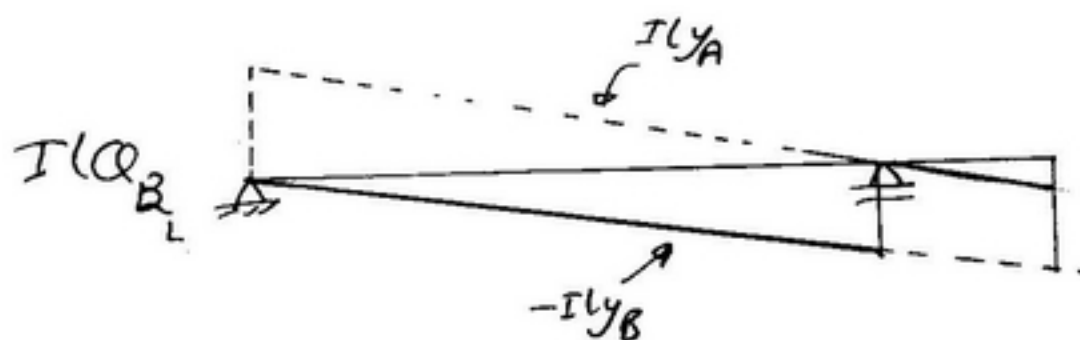
IL Q<sub>Br</sub>



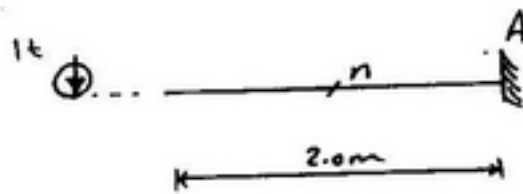
$ILQ_{BL}$



5' akei jo  $B_L$  akei ke  $\Delta$   
 Be Support  $\Delta$  ke li akei nik,



# Example 3

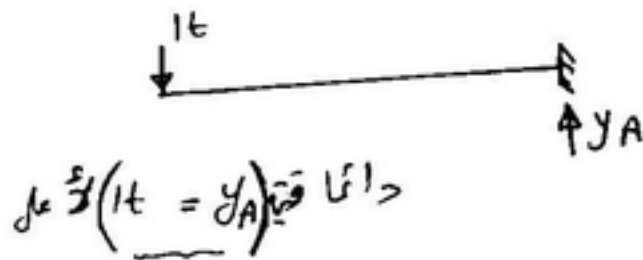


draw  
ILYA, Q<sub>A</sub>, M<sub>A</sub>

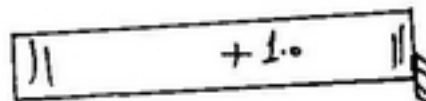
Q<sub>n</sub>, M<sub>n</sub>

— Sol —

ILYA



ILYA

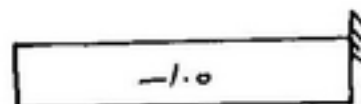


ILQ<sub>A</sub>

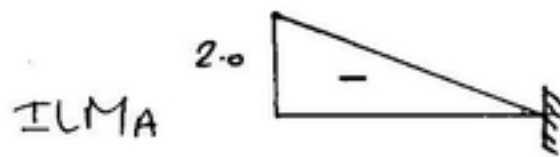


داتا سیکون 1k جنس 2.0m

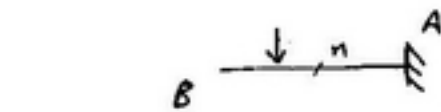
ILQ<sub>A</sub>



ILMA

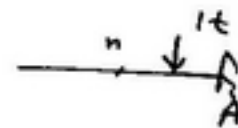


ILQ<sub>n</sub>



B → n

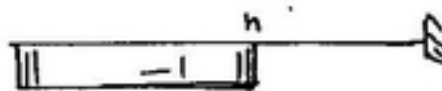
$$Q_n = -1$$



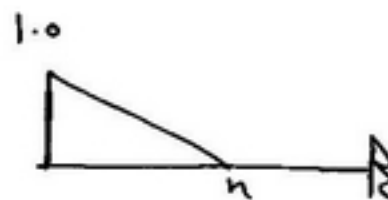
n → A

$$Q_n = 0.0$$

ILQ<sub>n</sub>

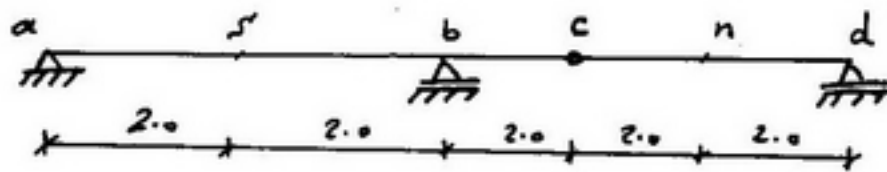


ILM<sub>n</sub>



### Example (4)

حالة الكمرات المتصلة - Intermed - نرى أن الجزاء التي يتحرك عليها  
الحمل فيؤثر على المحلوسين لها .



Req IL  $y_a$  ,  $Q_s$  ,  $M_s$  ,  $Q_{bR}$  ,  $Q_{bL}$   
 $Q_n$  ,  $M_n$  ,  $y_d$  ,  $M_b$

———— 5.0 ————

تلاحظ

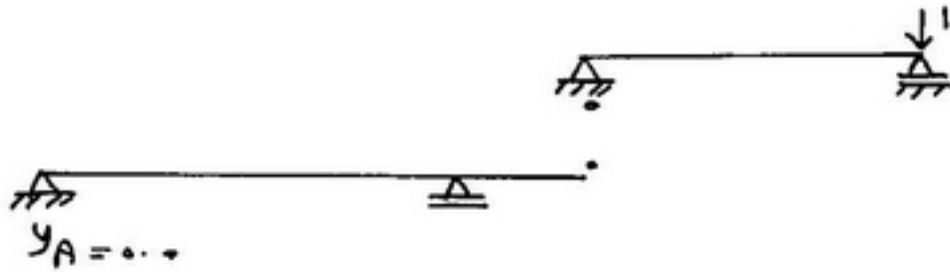
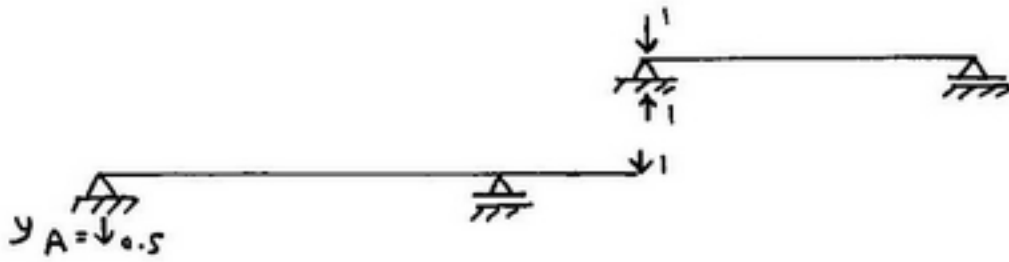
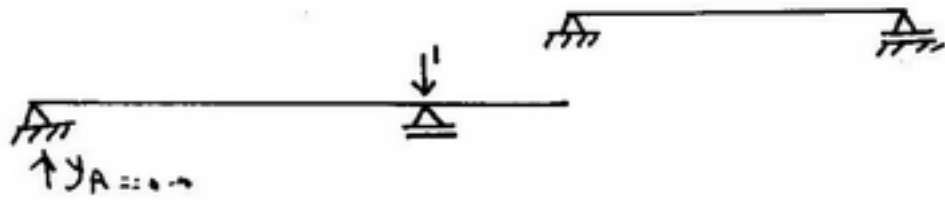
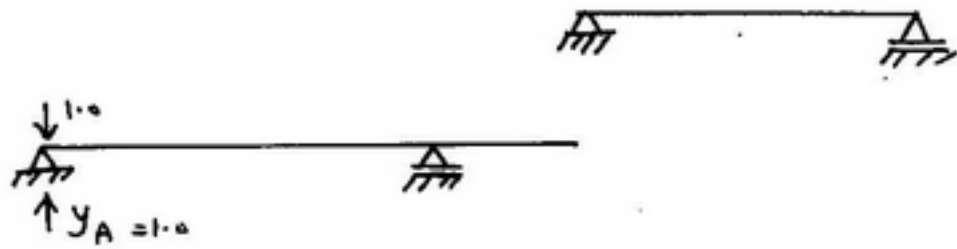


أنه الحمل  
يتحرك على الجزئية يؤثر على  
أن المطلوب بالكمرة التي تحت

ولكن عند أن المطلوب في الكمرات العلوية ( ١١.٠٠ ٥.٠٠ ) عن ما يكون الحمل  
في الكمرات السفلى لا يؤثر بل هو بعض



For  $y_A$

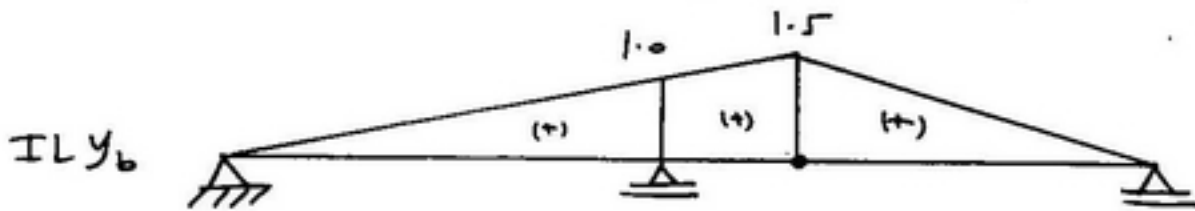


$IL y_A$



← یکبار رسم نه هر بار رسم نادر دل ایگر استغلی صده (→) تم اتوویل بالهنه  
ننه (d)

for  $ILy_b$



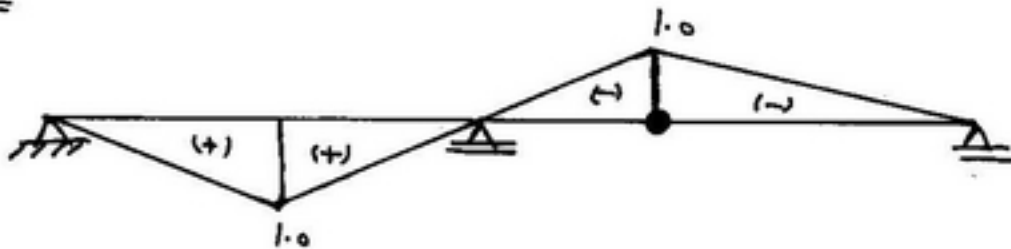
for  $Q_s$



هذا الجسر مثل الجسور المسماة تماماً

تم شيدته على شكل  
(0.5 → 0.5) قاذور.

for  $M_s$



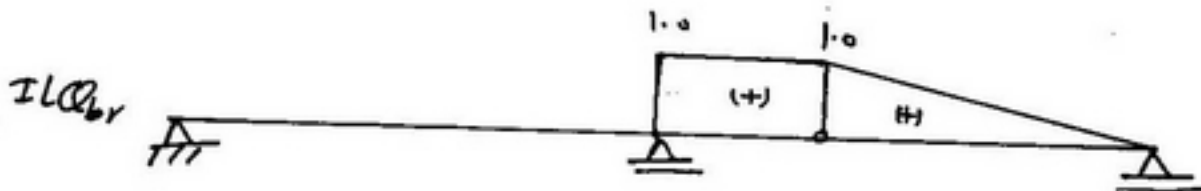
For IL Qbr



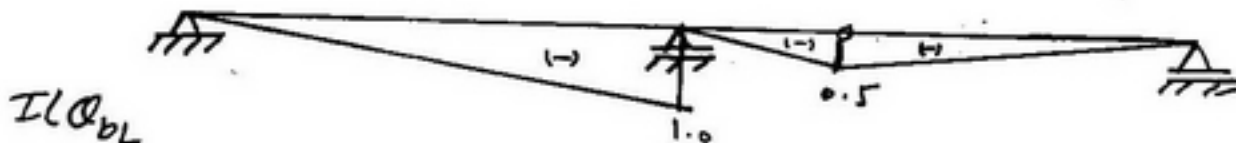
تأثير الحمل Cantilever

عبارته من تحليل قوتها حالة  
Cantilever

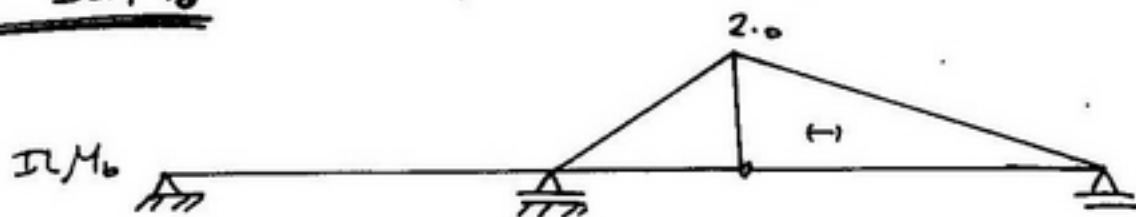
من تحليل تحت حالة  
Cantilever



For IL Qbr

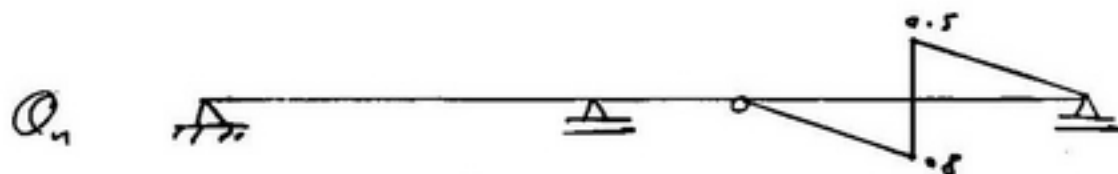
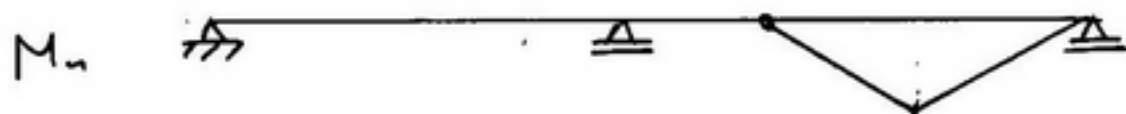


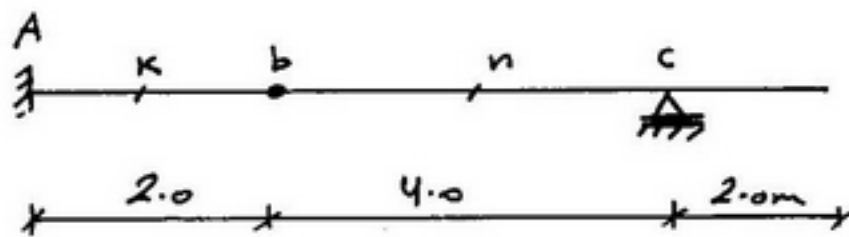
For  $IL M_b$



$IL(Q_n, M_n, y_d)$

تابع للمركز العلوي، وبالتالي يتم رسمه على نقطة، وإتق (صفر)





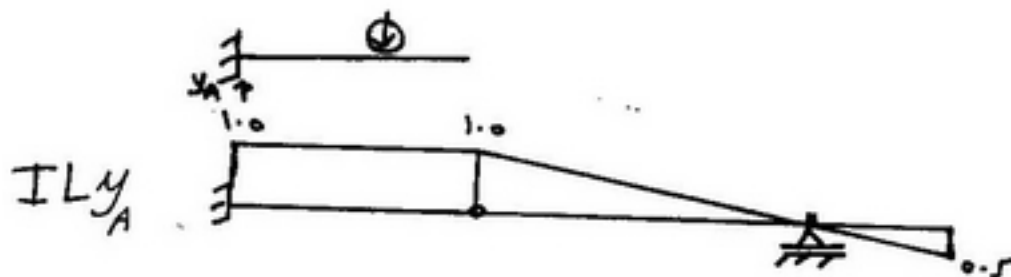
draw  $IL y_A, Q_k, M_k$

$IL Q_n, M_n, y_c, M_c$

— 5.2 —



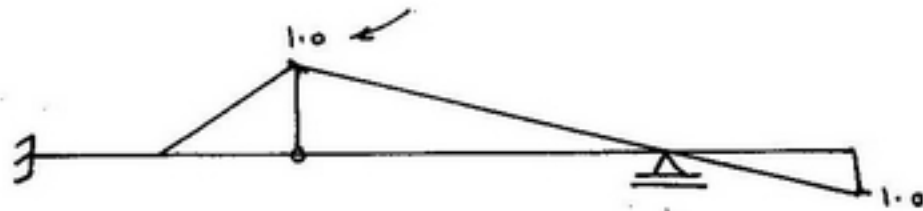
①  $IL y_A$



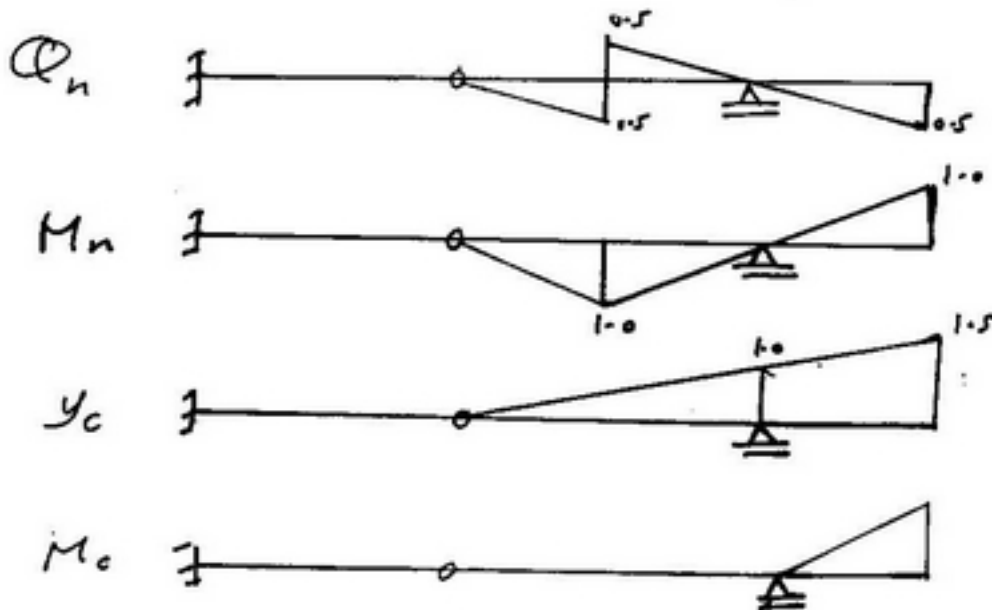
IL  $Q_k$



IL  $M_k$



IL  $Q_n$ ,  $M_n$ ,  $y_c$ ,  $M_c$  → تابع جزاء لاندل  
 ∴ س نيسنه (على جزاء لاندل نقطه)

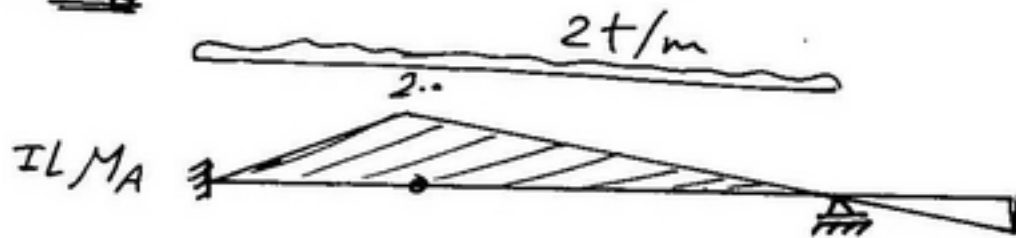


مطلوب آخر

$$M_A \leftarrow \begin{matrix} \text{max (B.M)} \\ \text{max (YA)} \\ \text{max (Q_A)} \end{matrix} \rightarrow \text{مطلوب}$$

• ناتج حمل = (Uniform)  $2t/m$

II M<sub>A</sub>



يتم وضع الحمل على أحد المساحات (أما العلوية أو السفلية) ويتم ضربها في  
الحمل (الحمل \* المساحة) حالة الحمل الموزع.  
ولا يهم أنه تكون المساحة سالبة أو موجبة.

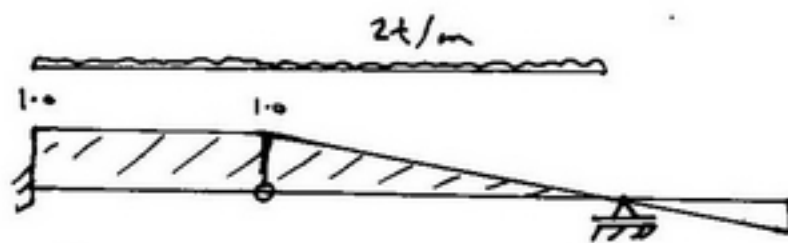
← من هذا المثال المساحات الأكبر موقعة -

$$M_{A_{max}} = \left( \frac{1}{2} \times 2 \times 2 + \frac{1}{2} \times 4 \times 2 \right) \times 2t/m$$

$$= 12 t.m.$$

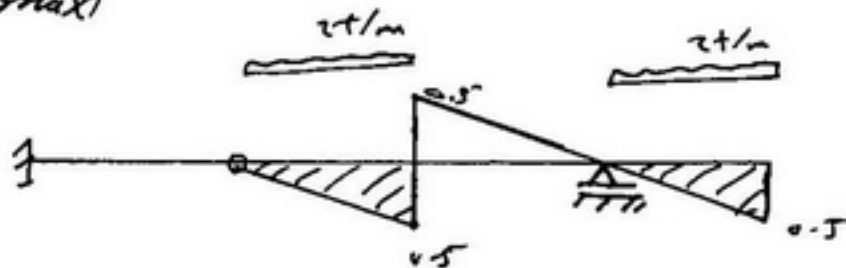
لا تضع أحمال على الجدران الخفيفة لأنها مساحته باتجاه عاكسة للمساحة  
العلوية ، بالتالي تقلل ← العزم .

2  $y_A$  (max)



$$y_{A_{max}} = 2 \times \left[ 1 \times 2 + \frac{1}{2} \times 1 \times 4 \right] = 8$$

3  $Q_n$  (max)



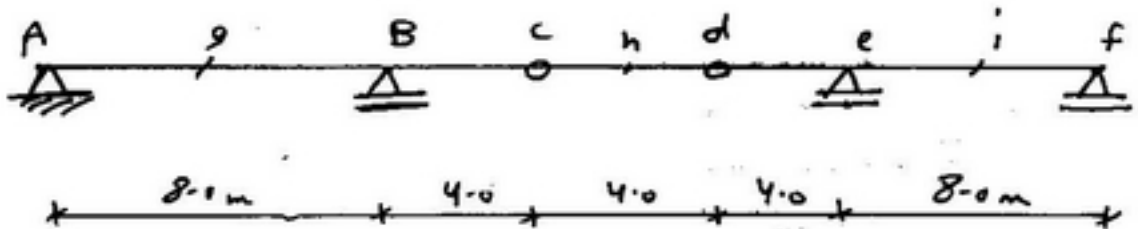
$$\begin{aligned} \text{Area} &= \frac{1}{2} (0.5 \times 2) + \frac{1}{2} (0.5 \times 2) \\ &= 1 \end{aligned}$$

$$\therefore Q_{n_{max}} = 2 \times 1 = 2 \text{ ton.}$$



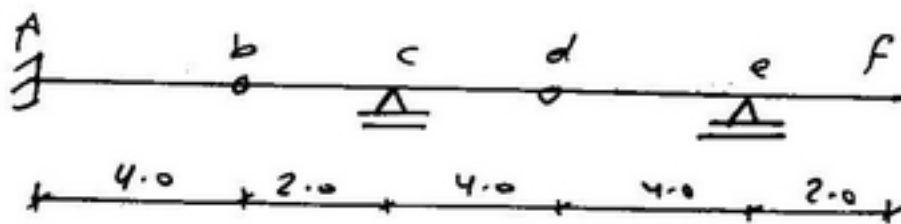
# H.W

1



Req  $y_A, y_c, y_e$   
 $Q_g, Q_n, Q_i$   
 $M_g, M_n, M_i$   
 $M_b, Q_{BR}, Q_{RL}$

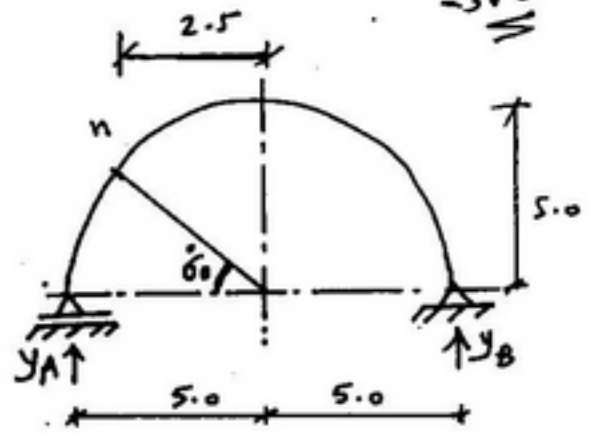
2



Req IL  $y_A, y_c, y_e$   
 $Q_A, Q_{CR}, Q_{ER}$   
 $M_e$

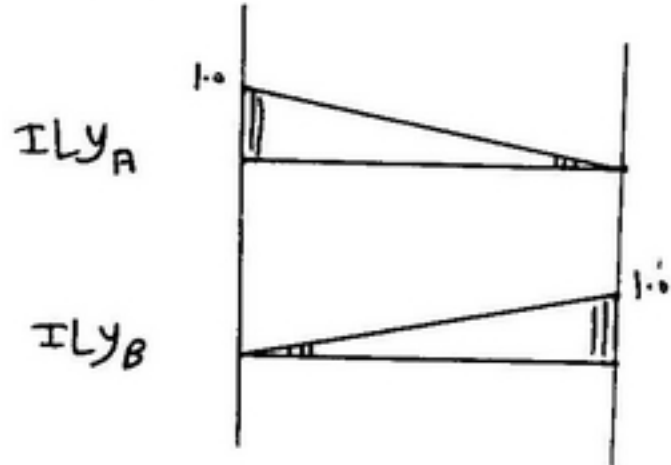
21

# Arch



draw IL  $y_A$ ,  $y_B$ ,  $N_n$ ,  $Q_n$ ,  $M_n$

— Sol —



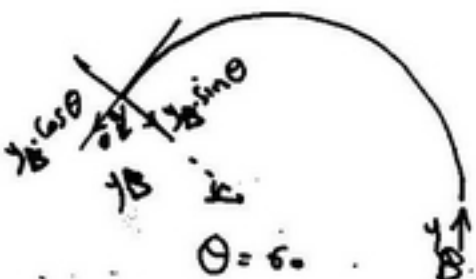
(It) From A  $\rightarrow$  n

من A إلى n

$$N_n = y_B \cos \theta = 0.5 y_B$$

$$Q_n = -y_B \sin \theta = -0.866 y_B$$

$$M_n = +7.5 y_B$$

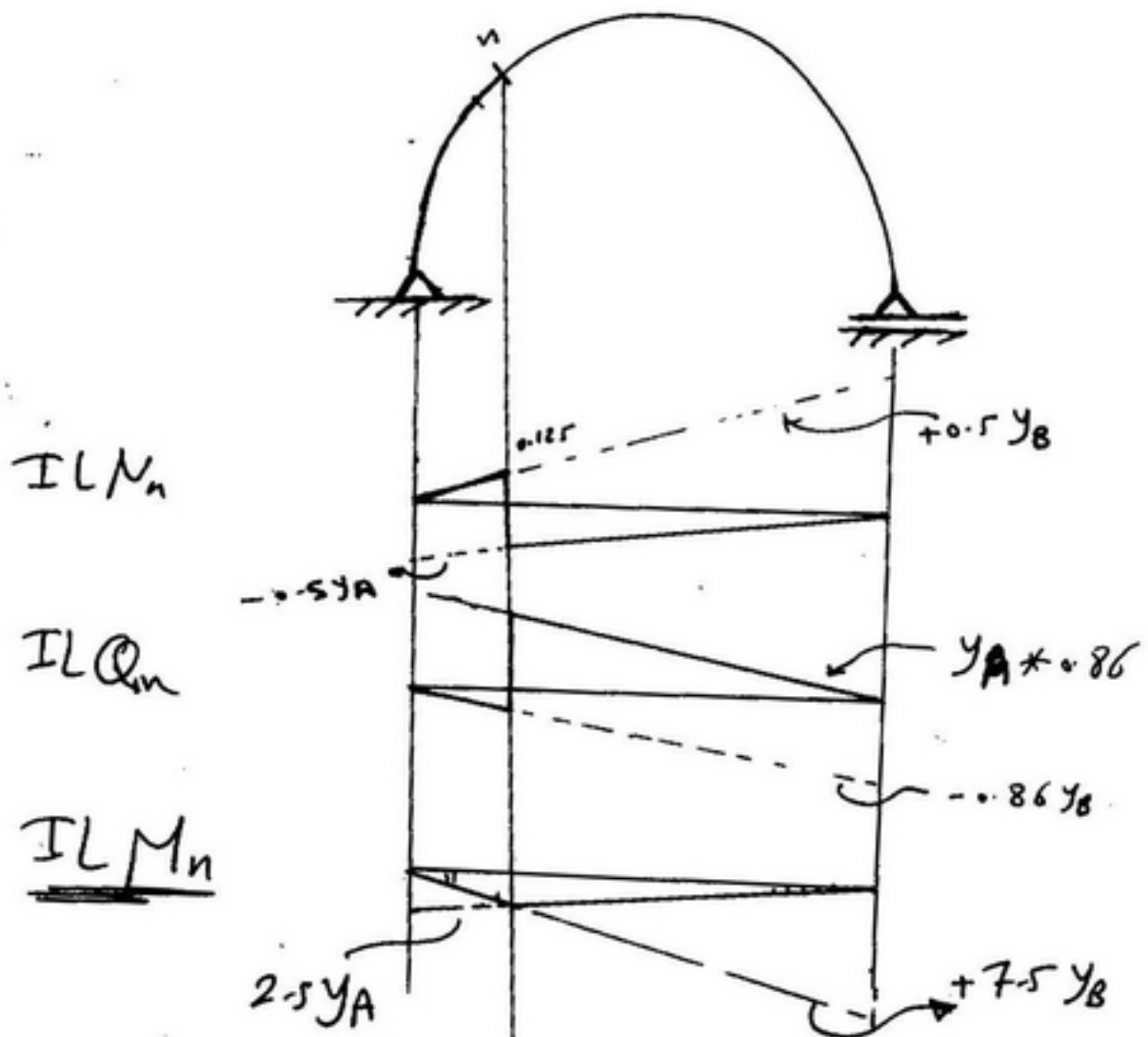
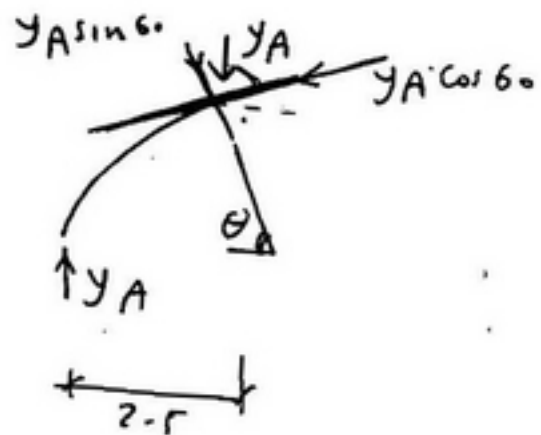


It move from n  $\rightarrow$  B

$$N_n = -Y_A \times 0.5$$

$$Q_n = +0.866 Y_A$$

$$M_n = 2.5 Y_A$$

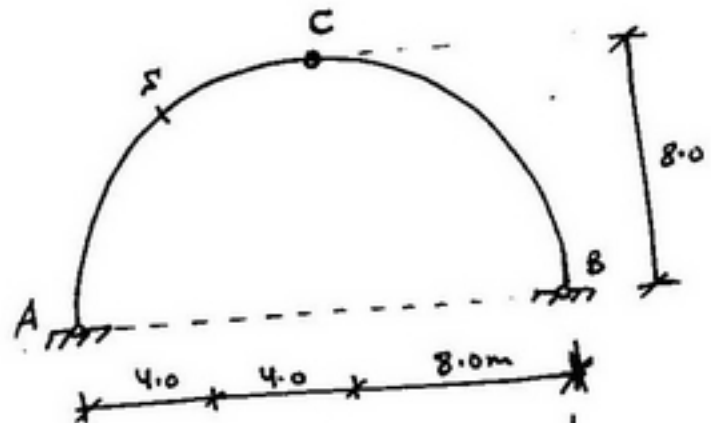


## Example 2

For the following Arch, construct the

ILs for

$Y_A, Y_B, X, M_s, Q_s, N_s$



Sol

ILY<sub>A</sub>

ILY<sub>B</sub>

ILX

I.LX

(1) From A → C

$$\rightarrow \sum M_{C,R} = 0$$

$$8X = 8Y_B$$

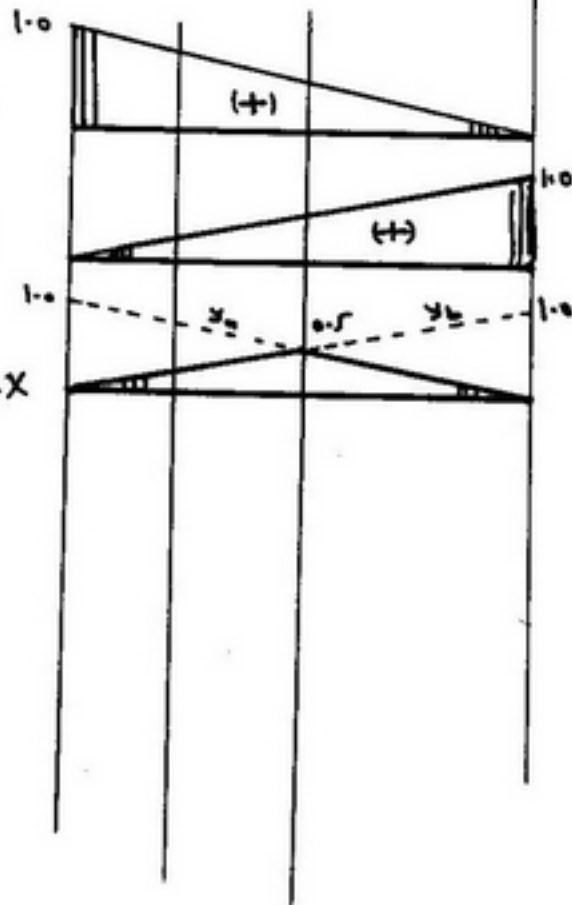
$$X = Y_B$$

From

C → B

$$\sum M_{C,L} = 0$$

$$X = Y_A$$

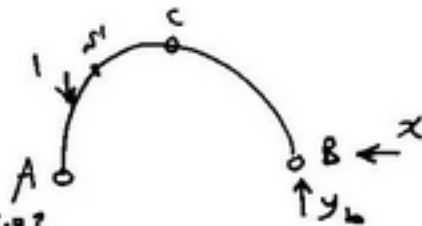


ILM<sub>s</sub>



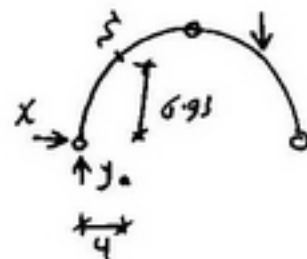
1. From A → s

$$\begin{aligned} \therefore M_{s'} &= y_b \times 12 - x \times 6.93 \\ &= 12 y_b - 6.93 x \end{aligned}$$



From s' → B

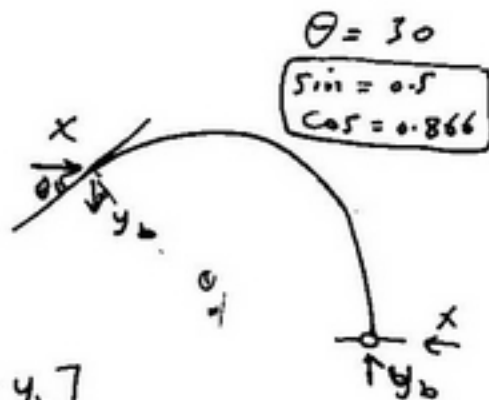
$$\therefore M_{s'} = 4 y_a - 6.93 x$$



ILQ<sub>s</sub>

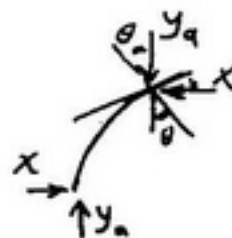
From A → s

$$Q_{s'} = -[0.5 x + 0.866 y_b]$$



From s' → B

$$Q_{s'} = [0.866 y_a - 0.5 x]$$



IL  $N_{s'}$

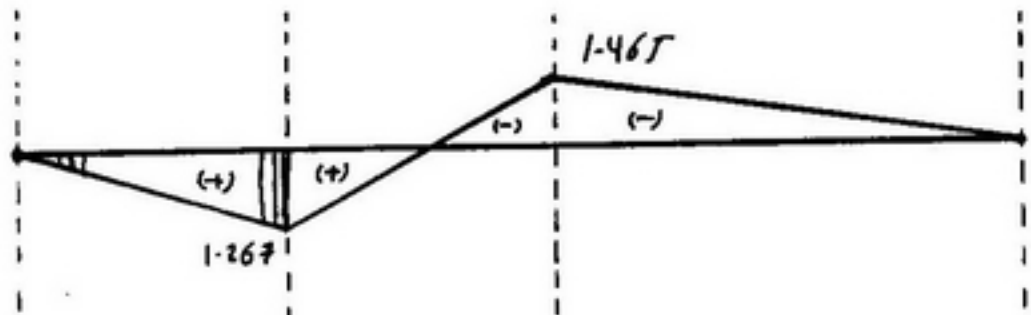
From A.  $\rightarrow$  s

$$N_{s'} = [0.5 y_b - 0.866 x]$$

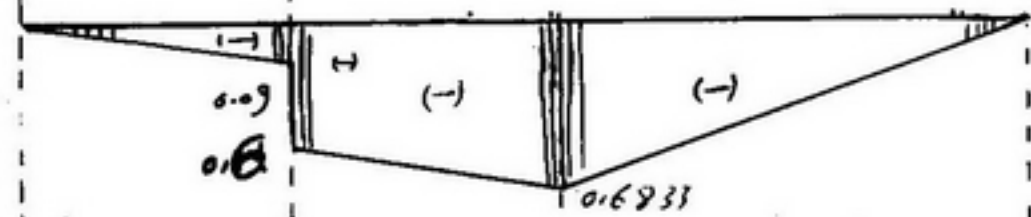
From s'  $\rightarrow$  B

$$N_{s'} = -[0.866 x + 0.5 y_a]$$

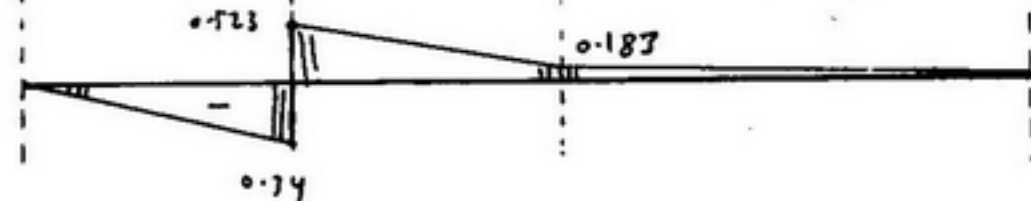
IL  $M_{s'}$



IL  $N_{s'}$



IL  $Q_{s'}$

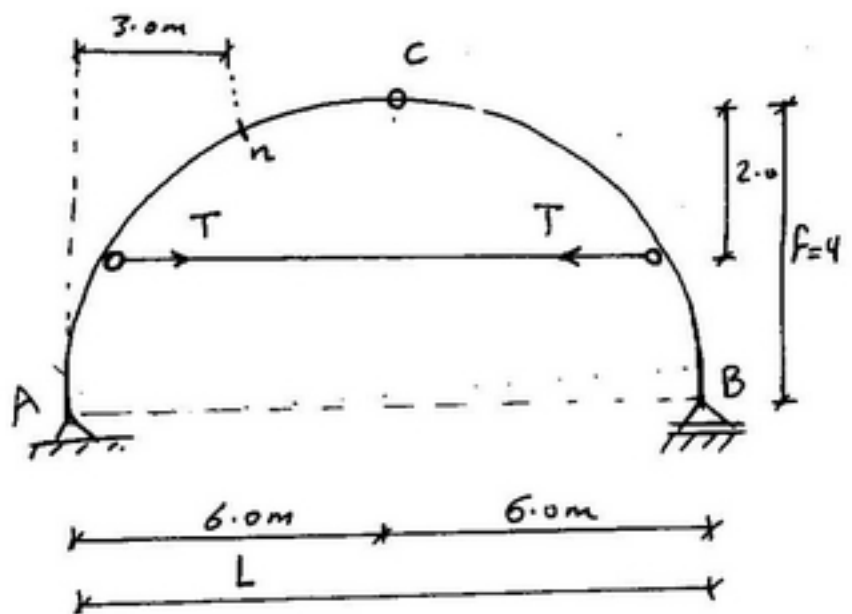


### Example (3)

$$y = \frac{4f}{L^2} (L-x)x$$

Req.:-

$y_A, y_B, N_n, Q_n, M_n$



— Sol —

$$f = 4.0 \text{ m}$$

$$L = 12 \text{ m}$$

$$\therefore y = \frac{4 \times 4}{12^2} (12-x)x = \frac{x}{9} (12-x)$$

$$\therefore \text{at } x = 3.0 \longrightarrow (y = 3.0)$$

$$\longrightarrow \tan \theta = y' = \left( \frac{4}{3} - \frac{2x}{9} \right) = \checkmark$$

$$(\theta = 33.69^\circ)$$

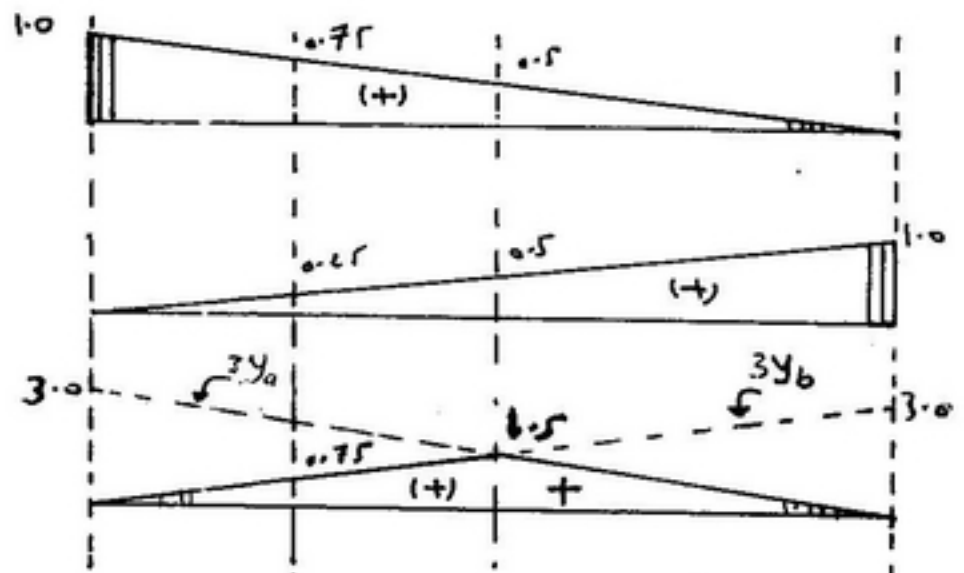
$$\sin \theta = 0.55$$

$$\cos \theta = 0.832$$

$ILY_A$

$ILY_B$

$ILT$

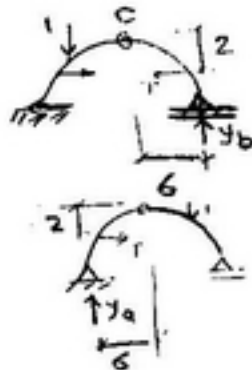


From A → C

$$T = 3 Y_b$$

From C → B

$$T = 3 Y_a$$



For  $Q_n, M_n, N_n$

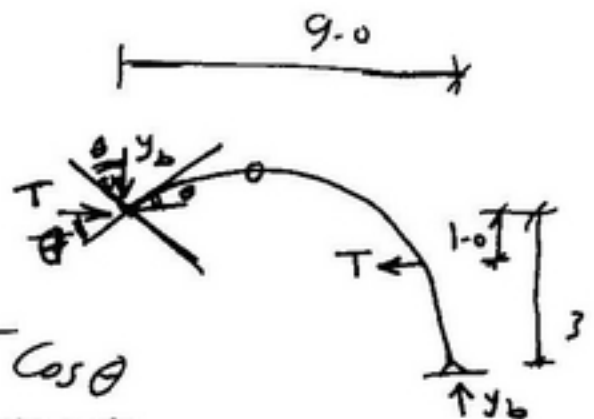
From A → n

$$N_n = Y_b \sin \theta - T \cos \theta$$

$$= 0.55 Y_b - 0.832 T$$

$$Q_n = -0.832 Y_b - 0.55 T$$

$$M_n = 9 Y_b - T$$



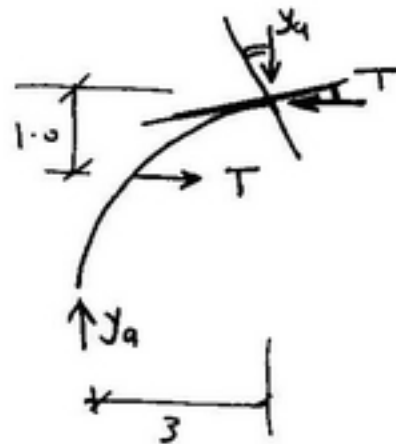


from  $n \rightarrow B$

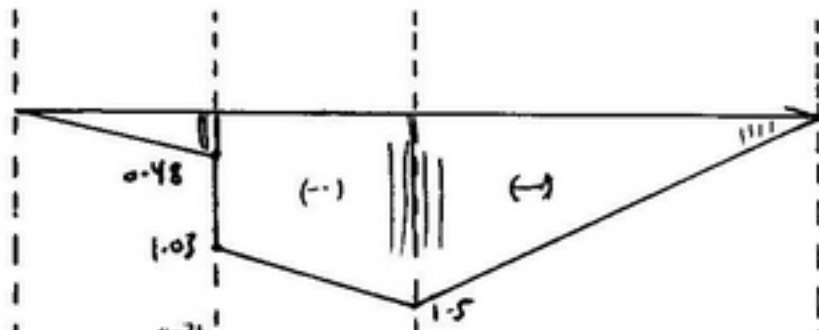
$$N_n = -0.832 T - 0.55 y_a$$

$$Q_n = +0.832 y_a - 0.55 T$$

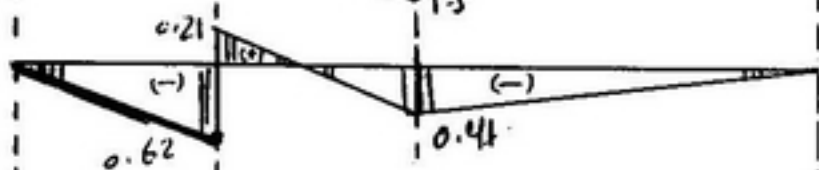
$$M_n = 3 y_a - T$$



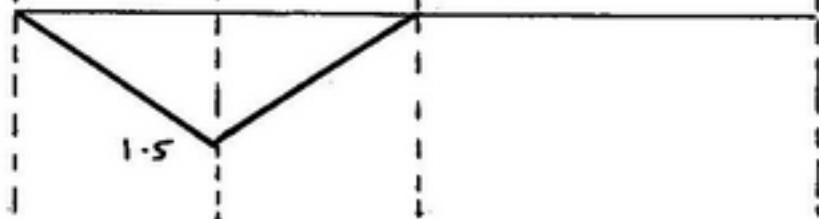
IL  $N_n$



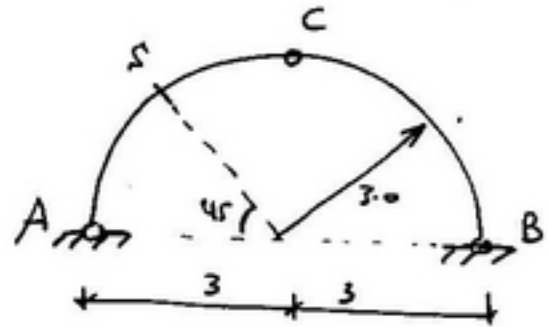
IL  $Q_n$



IL  $M_n$



Final 2004



Req

$IL\ y_A, y_B, x_B$

$M_s, N_s, Q_s$

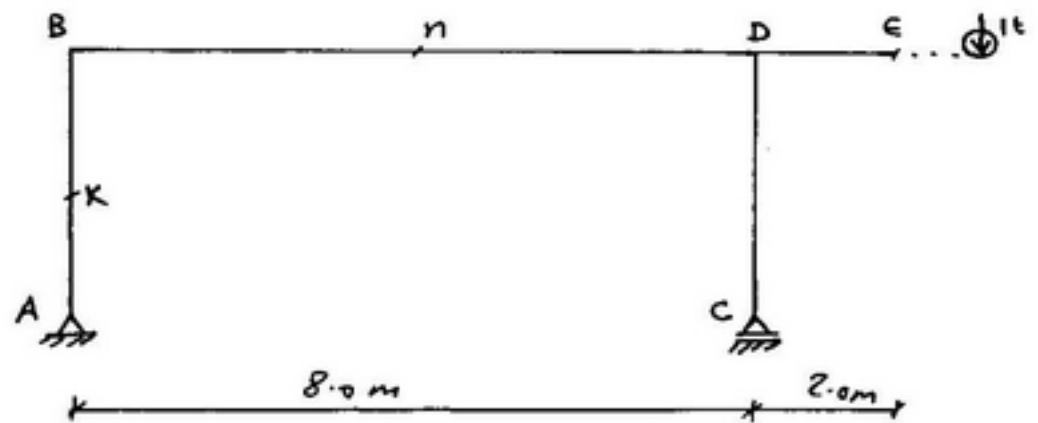
← Solve it

19  
1/10

بسم الله الرحمن الرحيم

Influence Line For

Frame



For the Following Frame

draw  $IL_{Y_A}$ ,  $IL_{Y_C}$

$IL_{Q_n}$ ,  $IL_{M_n}$ ,  $IL_{N_k}$

$IL_{Q_{D_R}}$ ,  $IL_{Q_{D_L}}$ ,  $IL_{M_D}$

— Sol —

لاحظ أنه لإيجاد Influence of vertical load  $X_A = \dots$

Link member  $AB$ ,  $CD$  ليس عليه تدرج  $\&$  تعمل ك Link member

$\&$  يمكن وضع hinge عند  $(B, D)$  نقطة، متحرك

في beam مادي

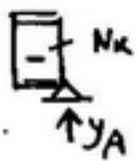
(1)

$ILY_A$

$ILY_c$

$ILQ_n$

$ILM_n$

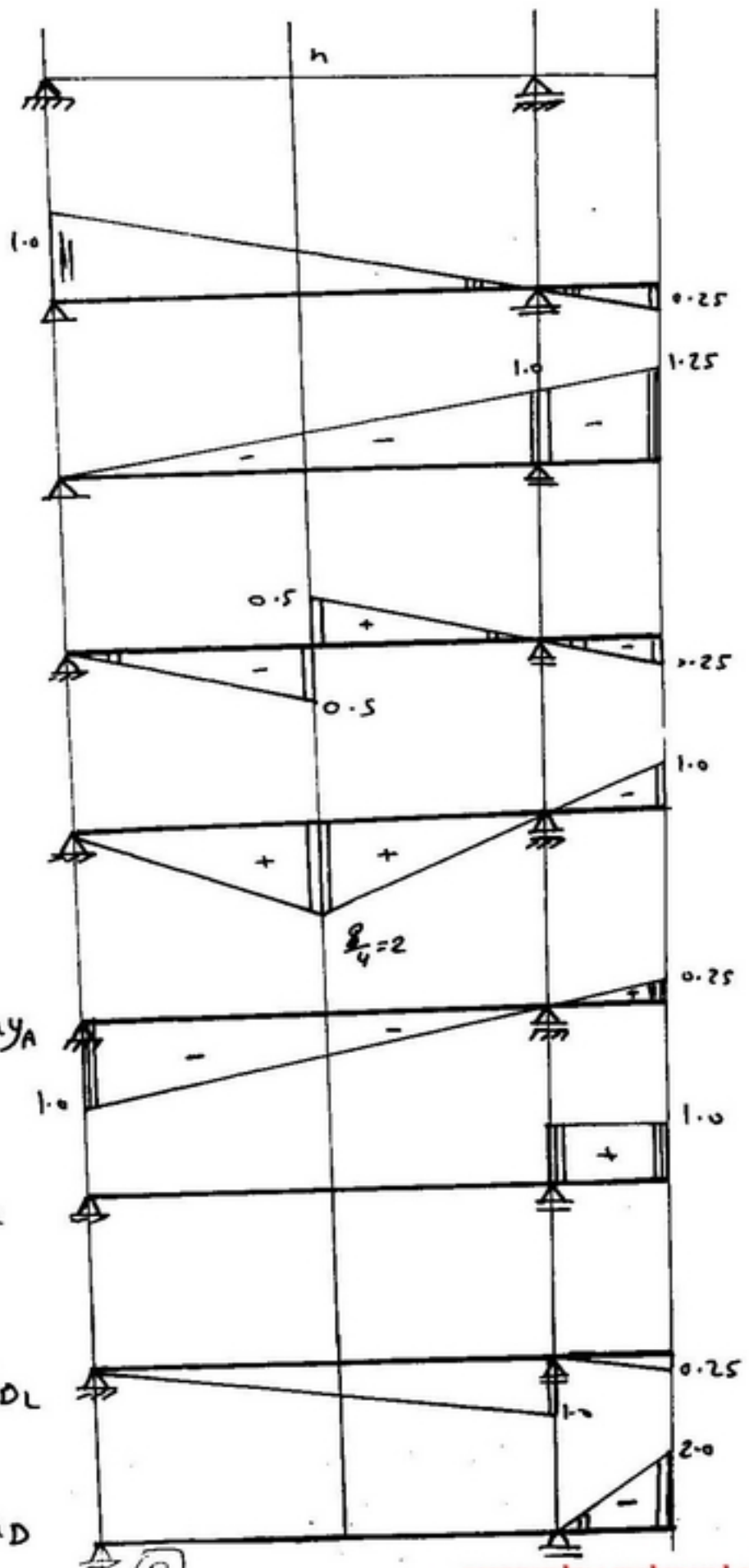


$ILN_k = -ILY_A$

$ILQ_{DR}$

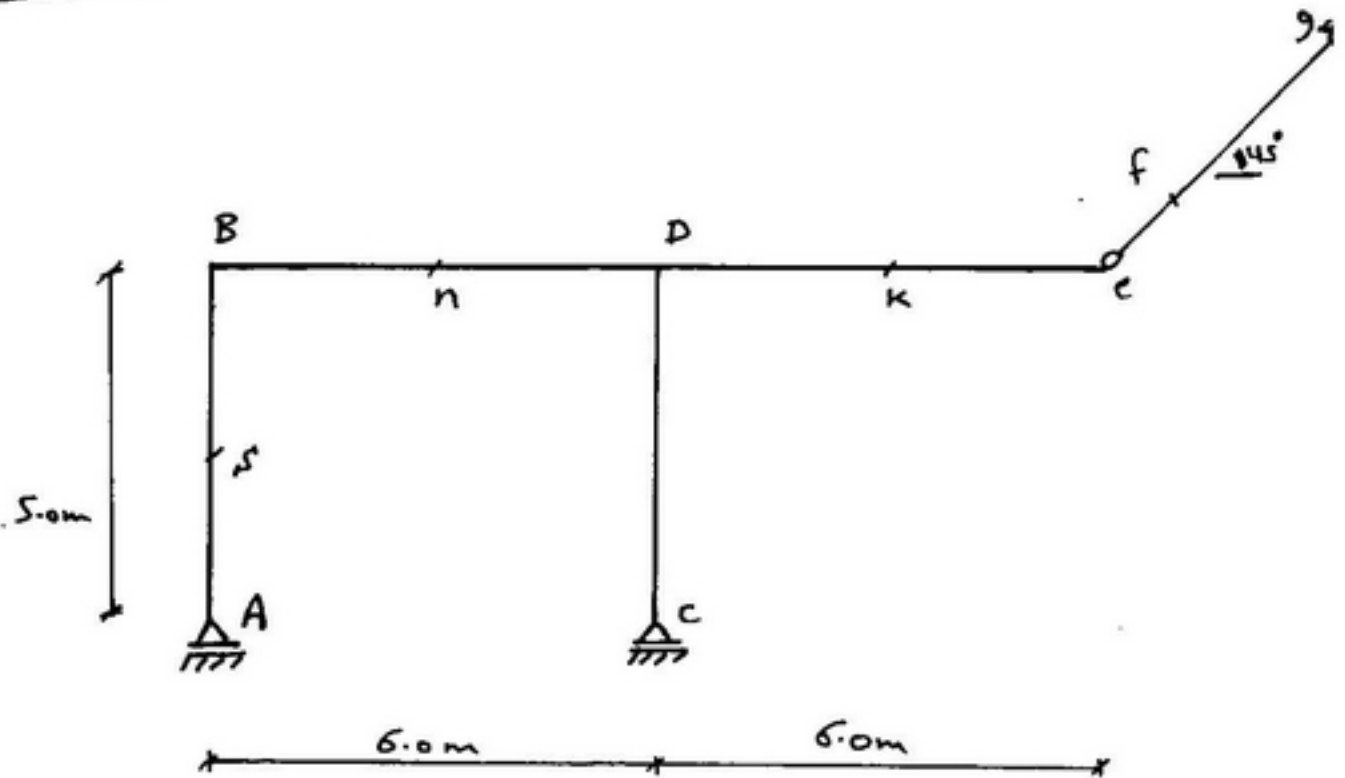
$ILQ_{DL}$

$ILM_D$



(2)

Final 2003



Required  $IL, y_A, y_c, N_s, Q_n, M_n$

$$Q_{DL}, Q_{DR}, M_D, Q_K, M_K, N_f$$

- 502 -

$F \sin \theta \uparrow$   
 $F \cos \theta \rightarrow$  ← Link (eg) 100%

$$F \cos \theta = 0.0$$

لا حظ لا يربح موز انضوي ٥٠٠

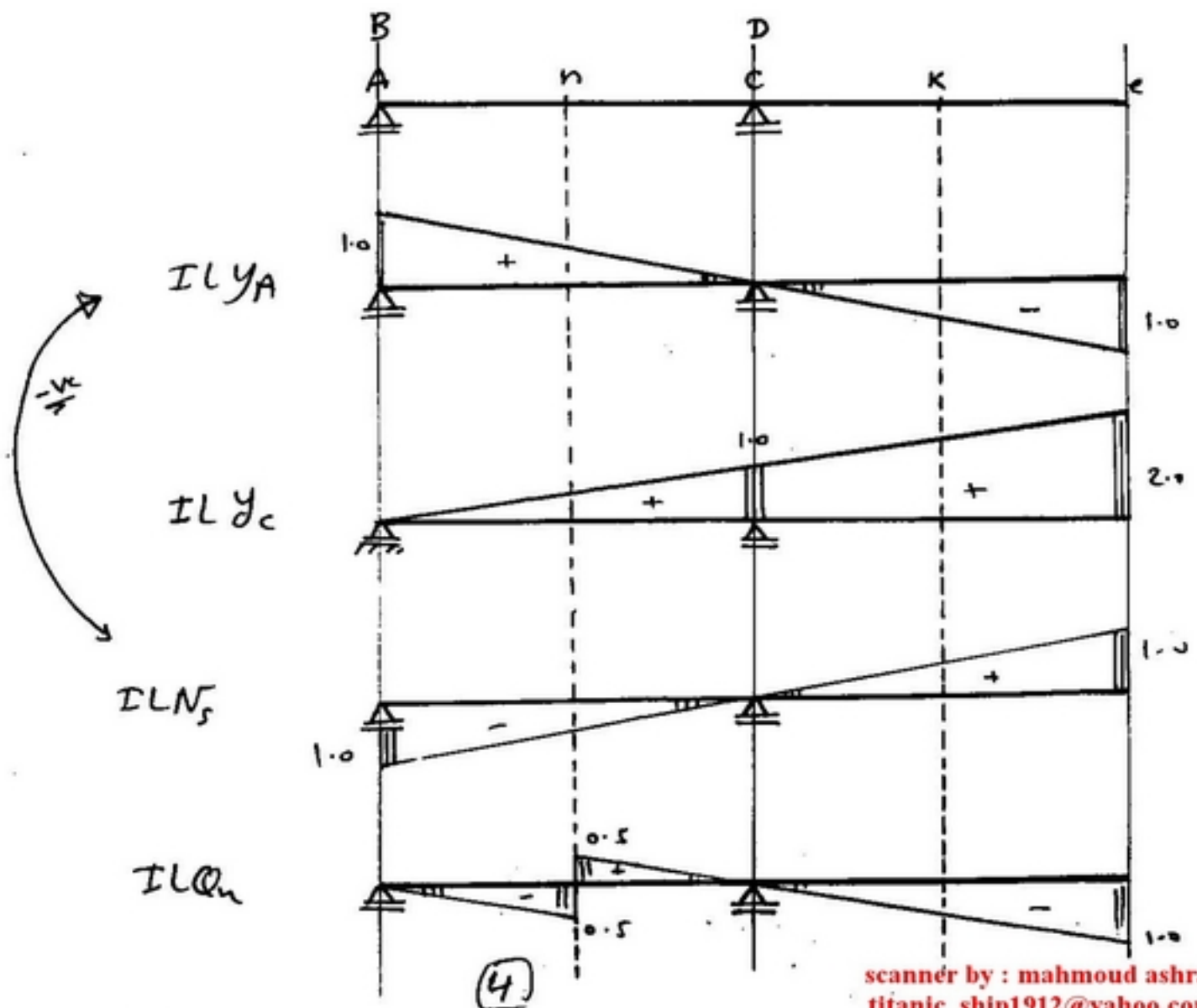
 $\Rightarrow F_{s \dots}$ 

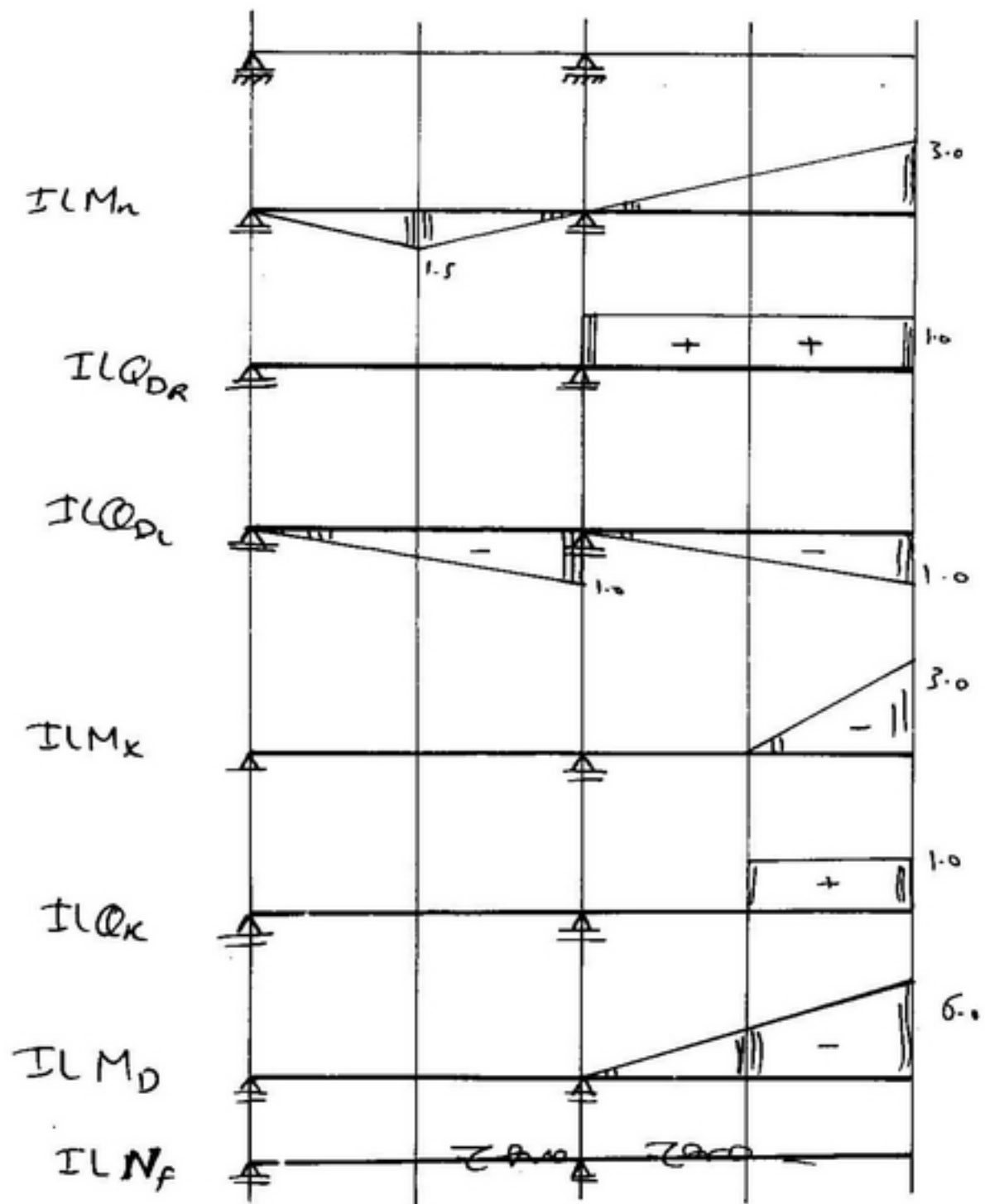
$\Rightarrow$  (link) + (iz) je d  
③ scanne  
titania

سازه های  
 frame + lig  
 سازه های  
 سازه های

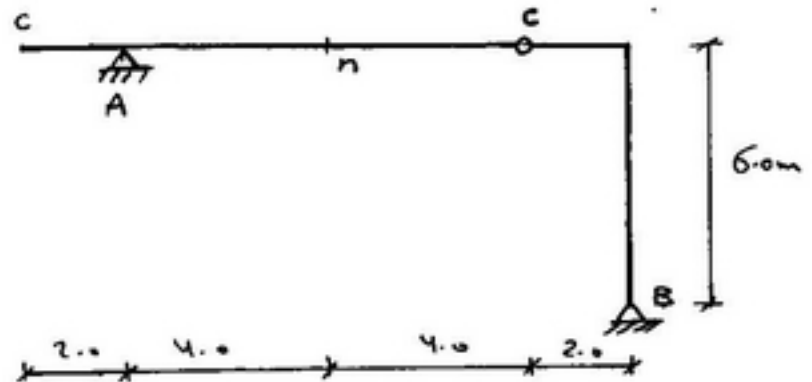
$$IL N_f = 0.0$$

$$IL N_s = -IL Y_A$$



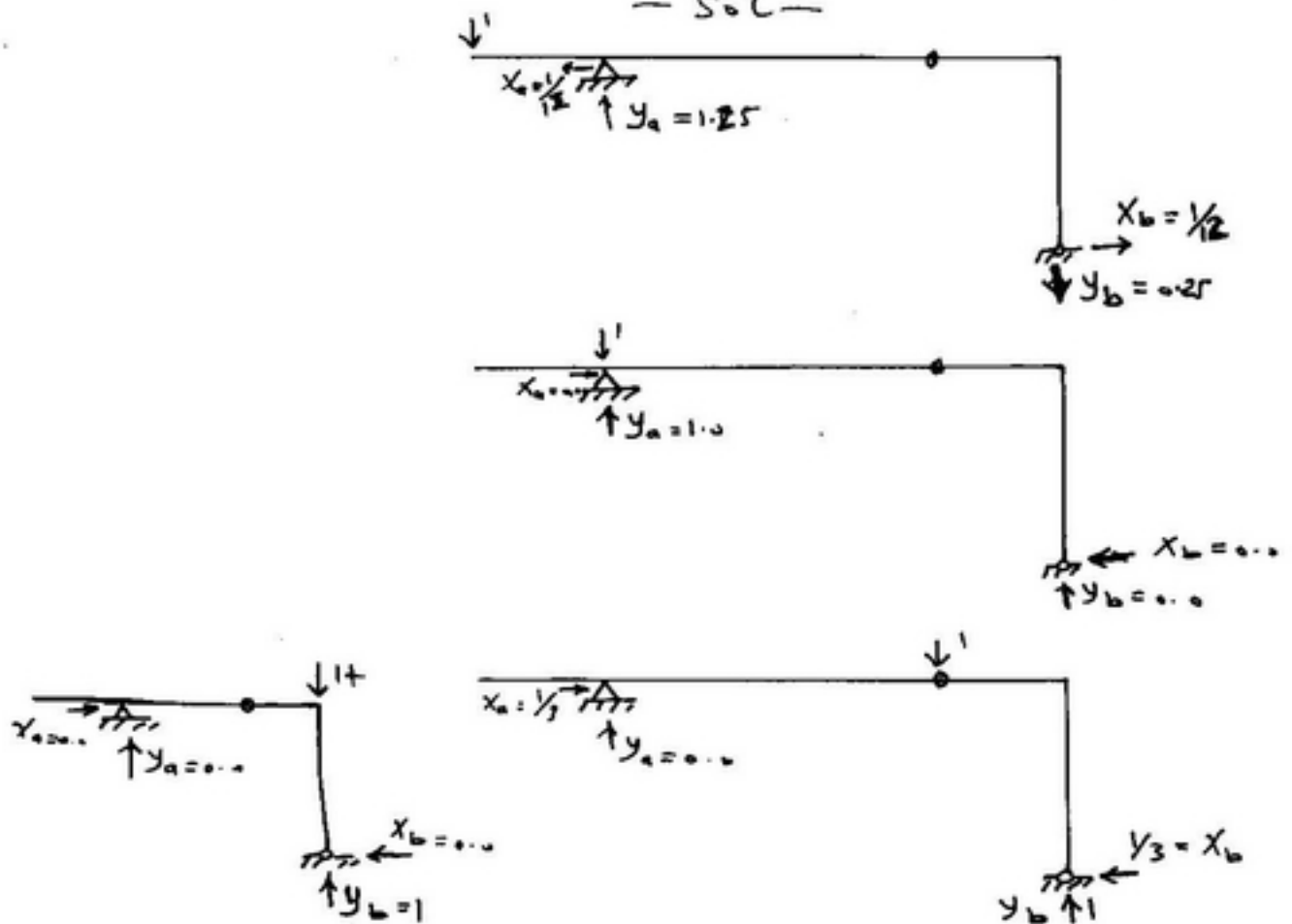


### Example ③



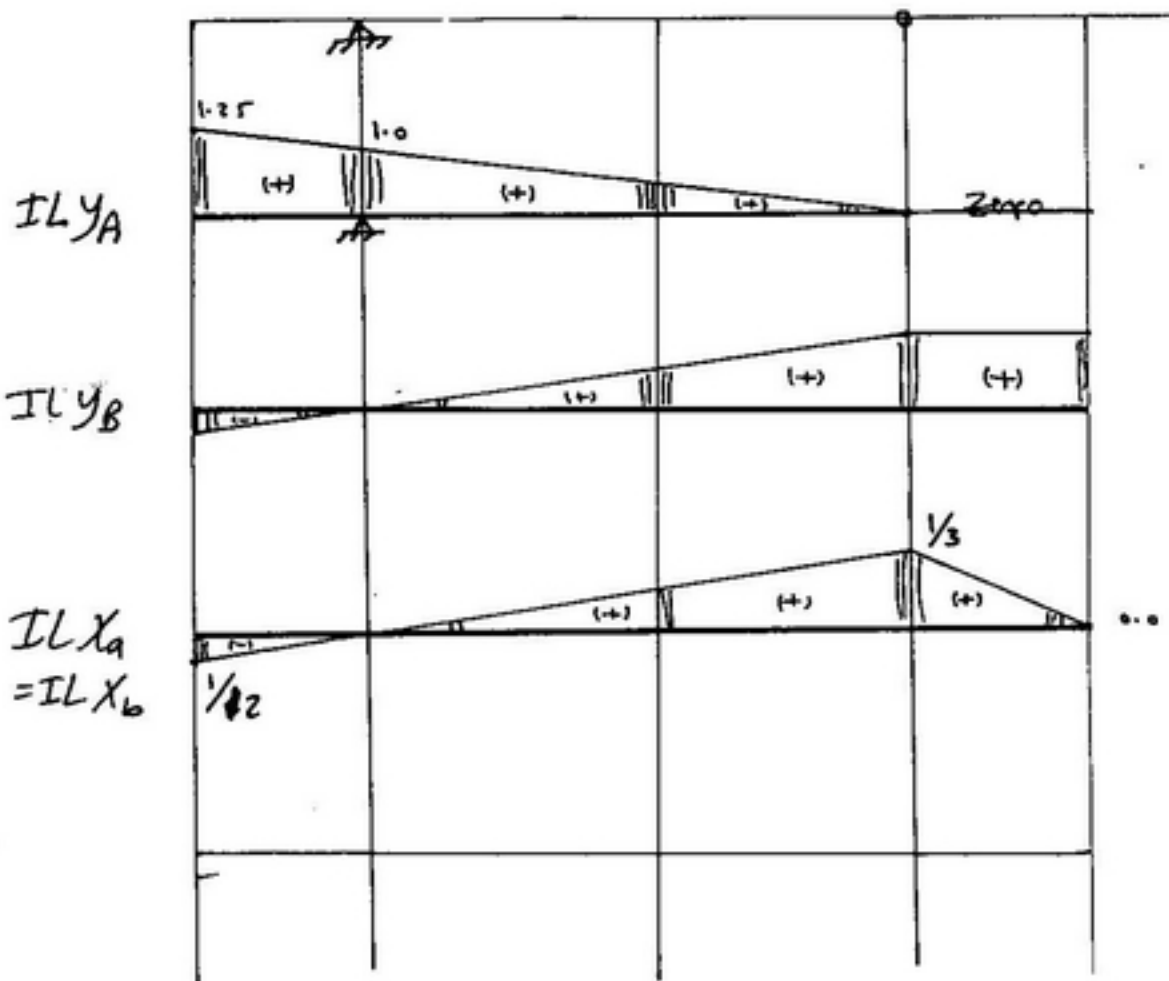
Req  $IL\ y_A, IL\ y_B, IL\ x_A, IL\ x_B$   
 $IL\ M_n, IL\ Q_n$ .

— Sol —

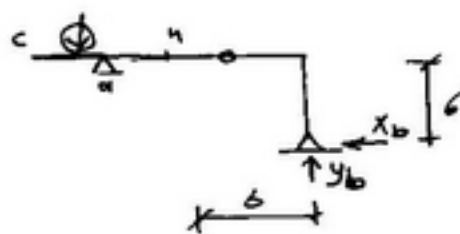


(6)





For IL  $M_n$



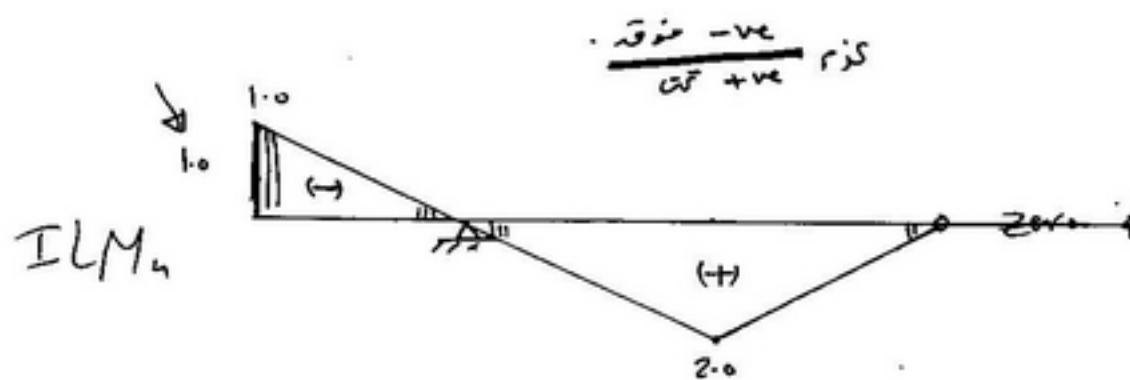
نما يتحرك الحمل من  $c \leftarrow n$   
ناب  $M_n$  يكون أقصى  
المحور

$$M_n = 6y_b - X_b \times 6$$

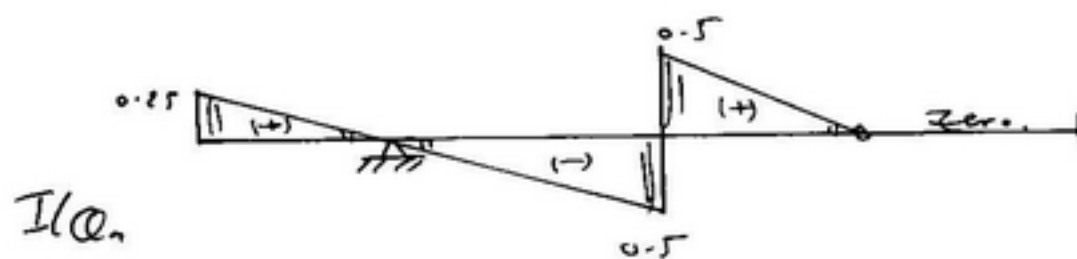
from  $n \rightarrow b$

$$M_n = 4y_a$$

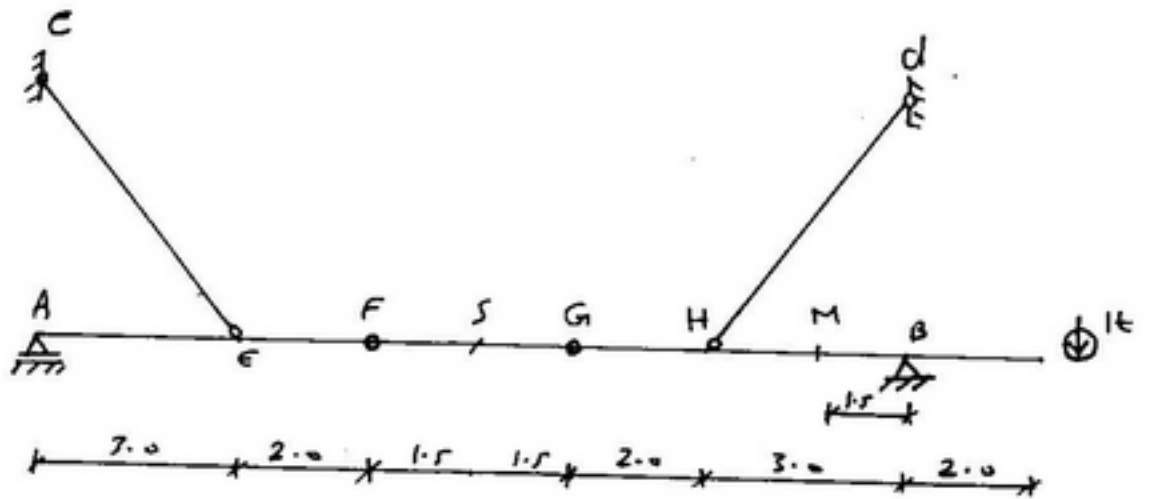
(7)



For  $Q_n$

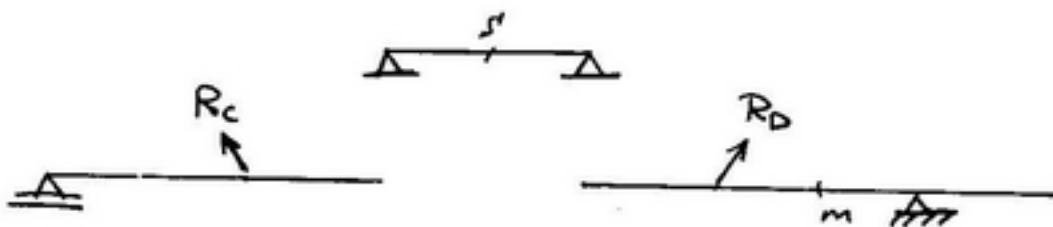


2004 5k



draw influence lines of  $y_A, y_B, R_C, R_D$   
 $X_b, Q_{Br}, Q_{BL}, Q_m$   
 $M_b, M_m, Q_s$  and  $M_r$

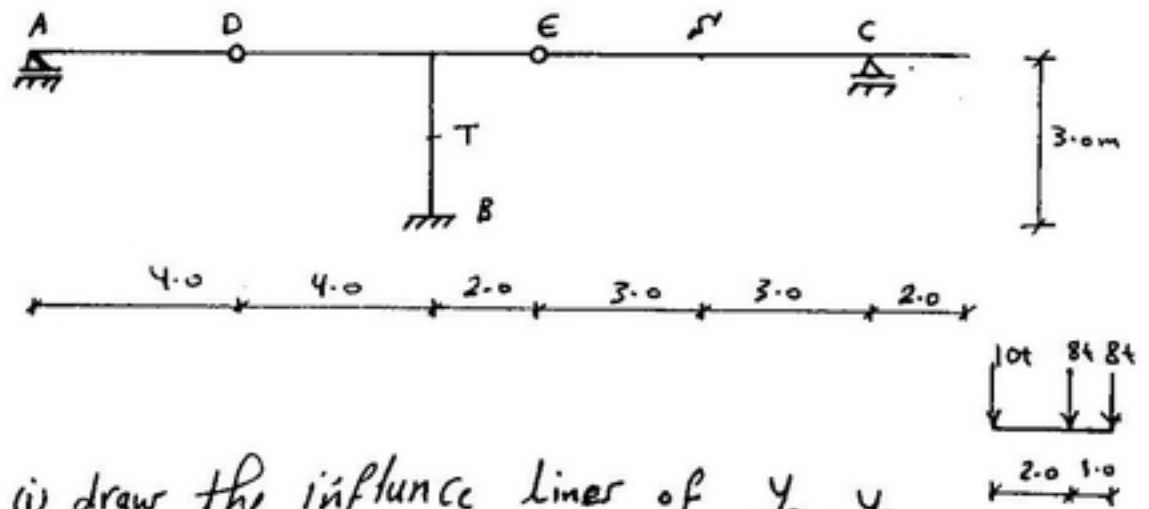
— Sol —



(9)

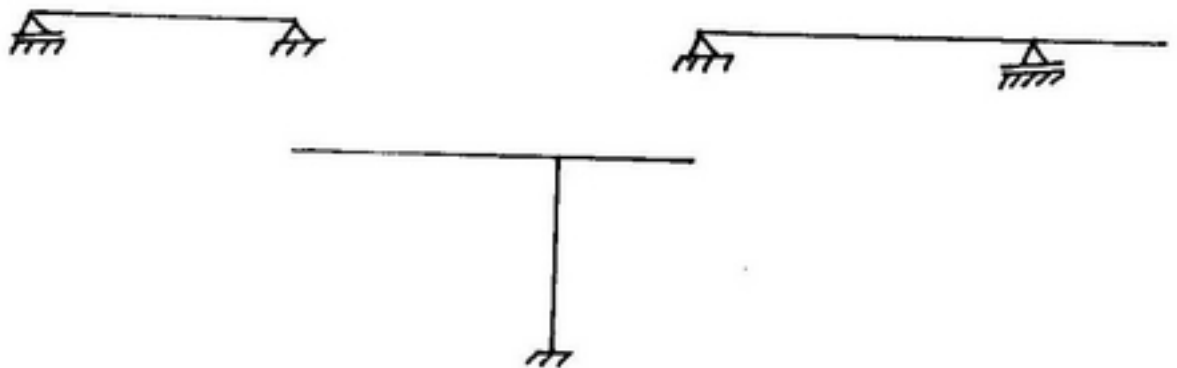


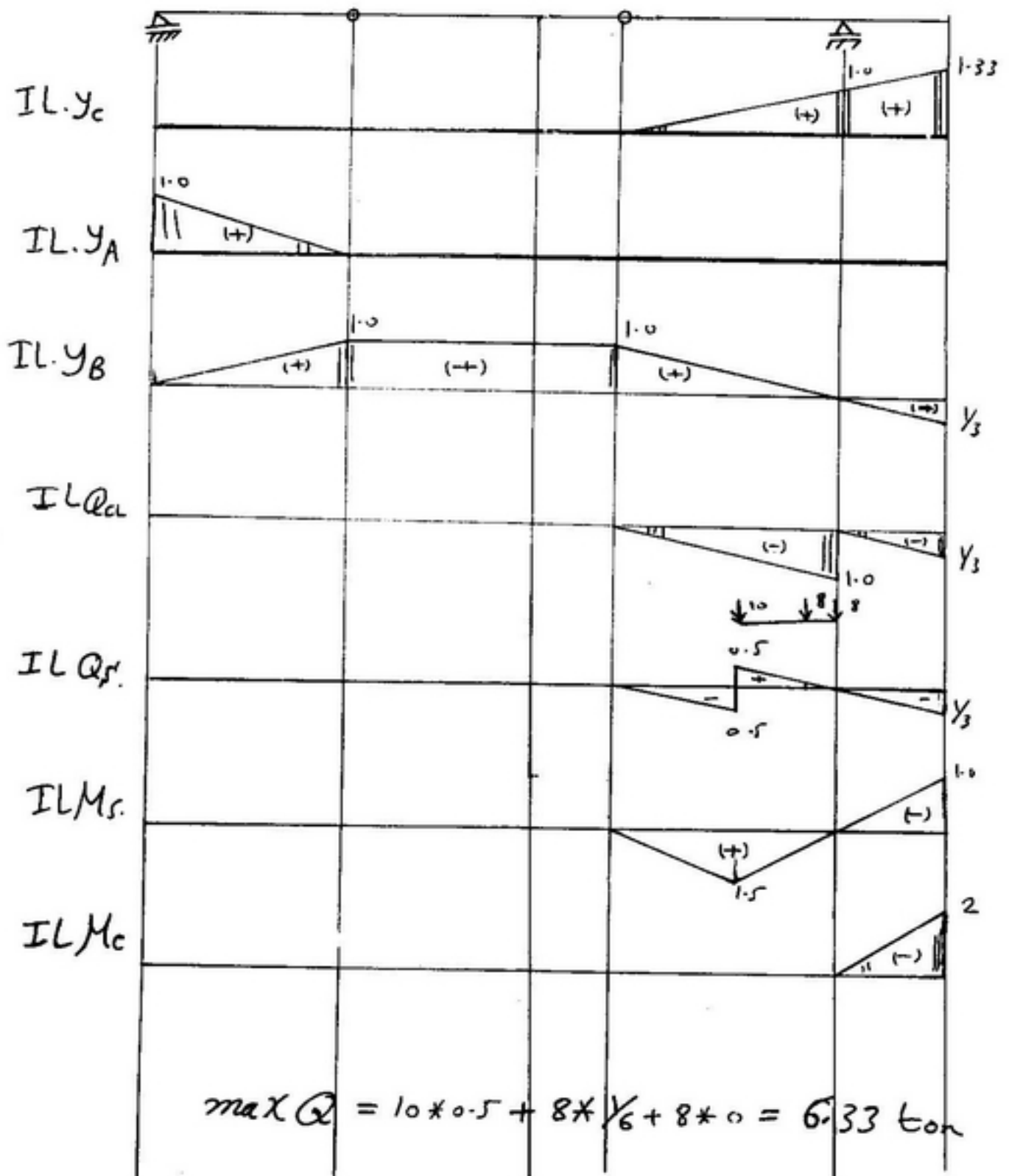
Final 2006



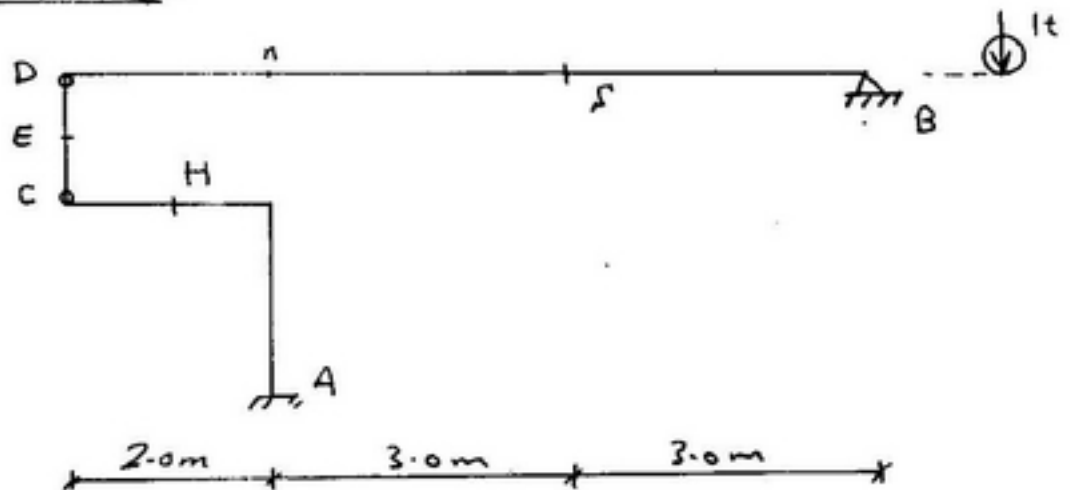
- (i) draw the influence lines of  $y_a, y_b, y_c, Q_c, M_b, M_c, Q_f$  and  $M_f$
- (ii) determine the max  $Q_f$  due to the given Loading system.

————— Sol —————





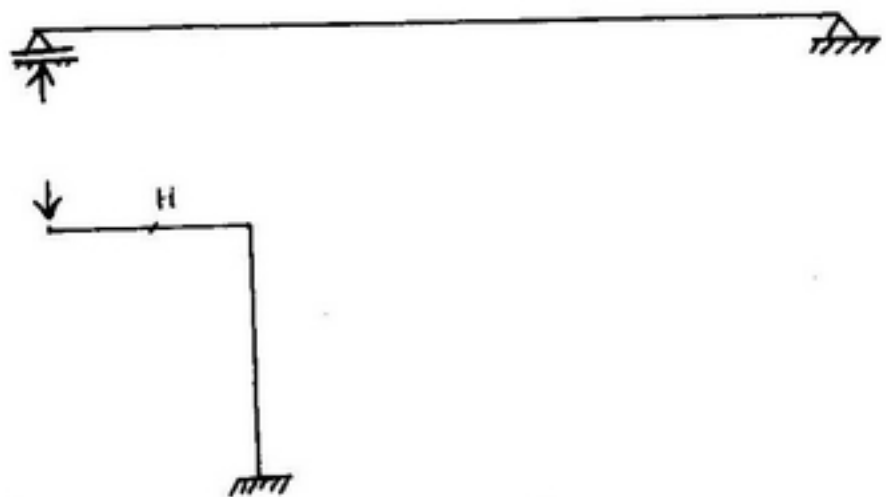
Final 2007



draw

$I_L, Y_A, Y_B, Y_D, M_A, Q_s, M_s, N_s, Q_H$   
for the shown frame.

————— SOL —————



(13)

$$IL y_A = IL y_D$$

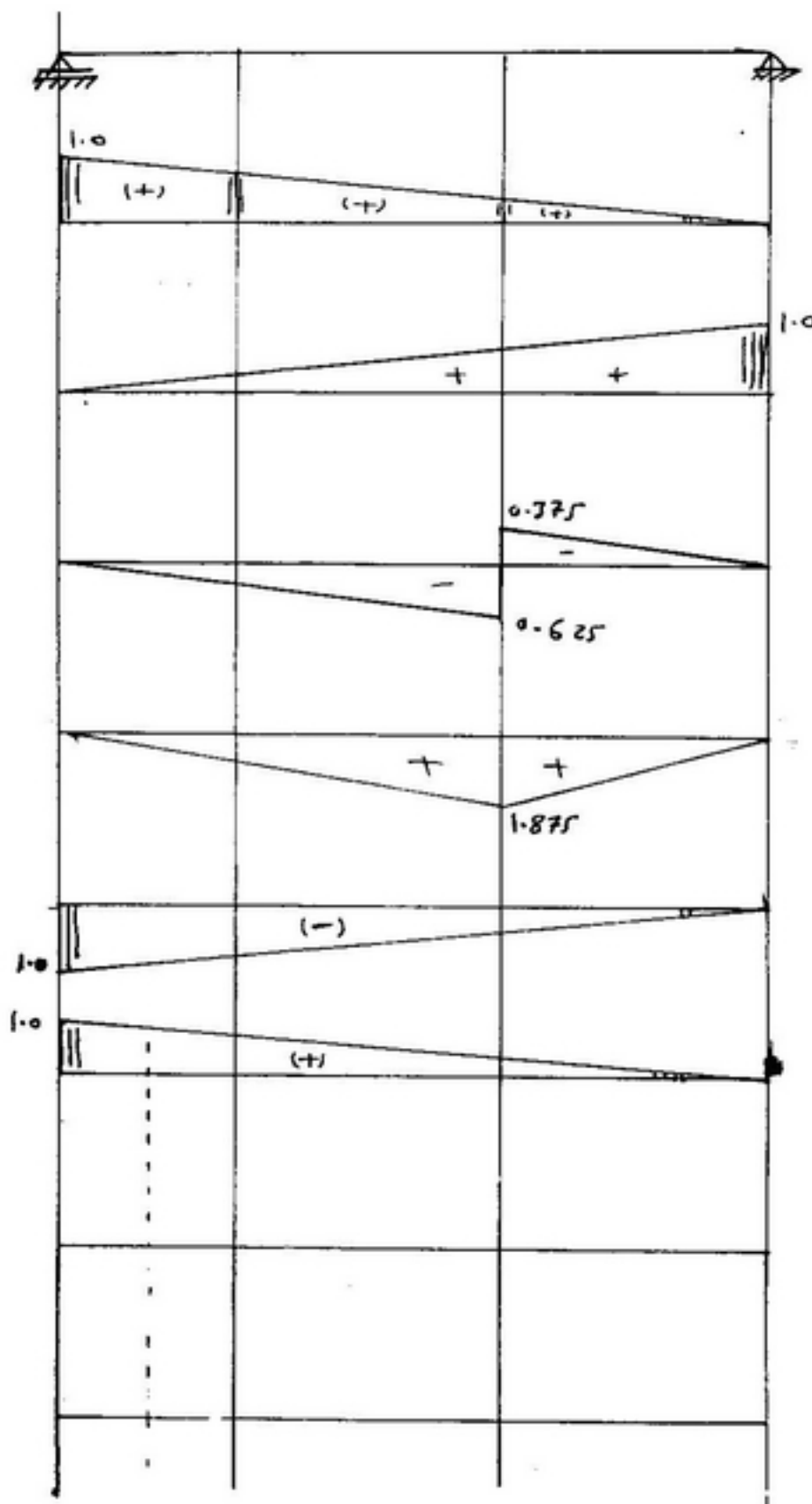
$$IL y_B$$

$$IL Q_s$$

$$IL M_s$$

$$IL N_e = -IL y_D$$

$$IL Q_H = IL y_d$$

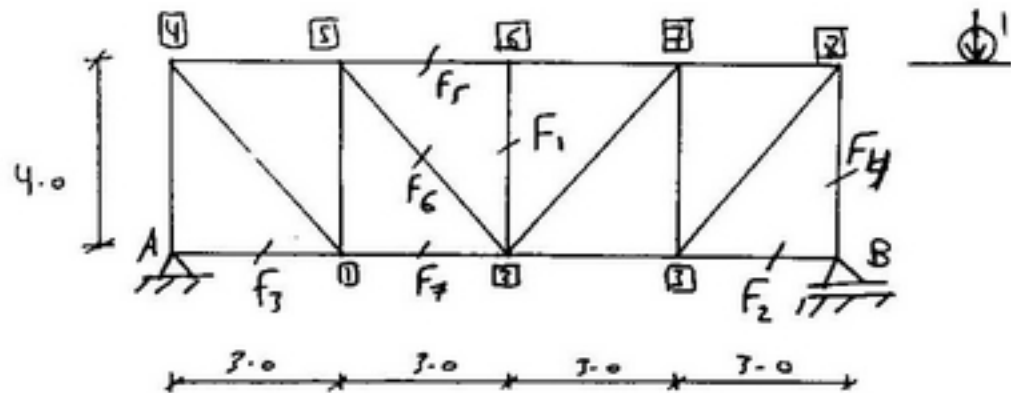




# 13.

truss

Cont. to Influence

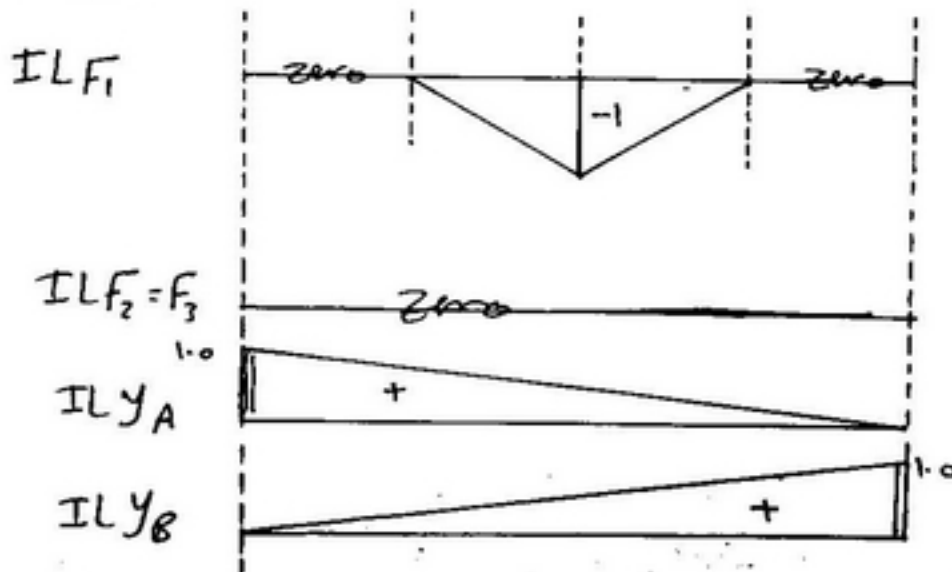


\*  $F_1 = 0$  ← 5 و 1! إذا وضع في مكانه

$F_1 = 0$  ← 8 و 7! إذا وضع في مكانه

ولكنه لن ياتي بوضع في مكانه 6  
 $F_1 = 1.0$

بما  $F_1 = -1 \text{ ton}$



(1)



$$\Rightarrow \sum M_5 = 0.0$$

$$4 F_7 = 9 y_b$$

$$\boxed{F_7 = 2.25 y_b}$$

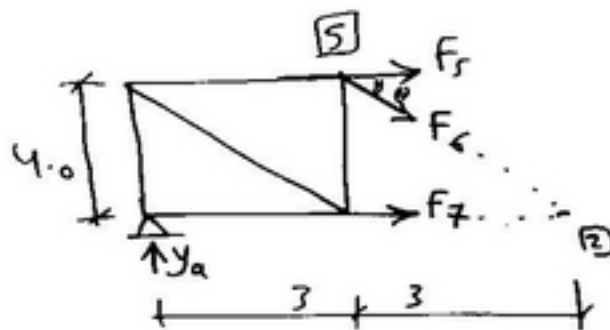
$$\Rightarrow \sum y = 0.0$$

$$F_6 \sin \theta + y_b = 0.0$$

$$\boxed{F_6 = -1.25 y_b}$$

T من جزر استال

← عند ما يتحرك ← [6] ← [8]



$$\sum M_2 = 0.0$$

$$\Rightarrow 4 F_5 + 6 y_a = 0.0$$

$$\boxed{F_5 = -1.5 y_a}$$

$$\sum M_5 = 0.0$$

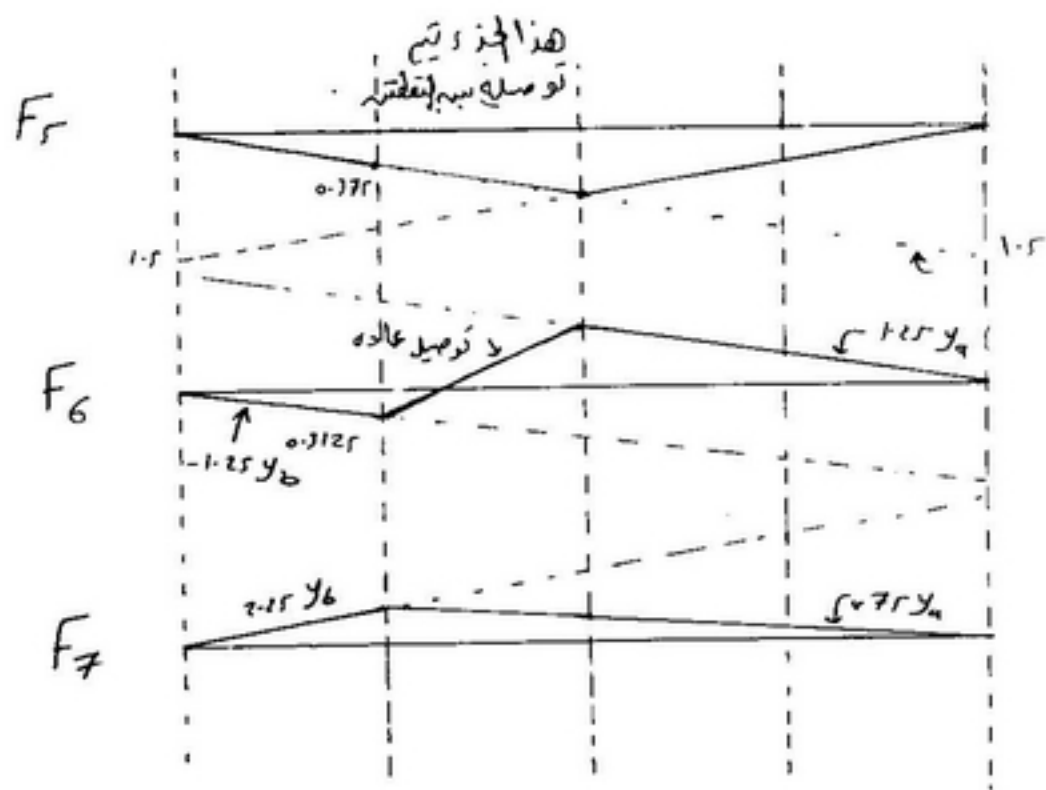
$$\Rightarrow 3 y_a = 4 F_7 \Rightarrow \boxed{F_7 = 0.75 y_a}$$

$$\sum y = 0.0$$

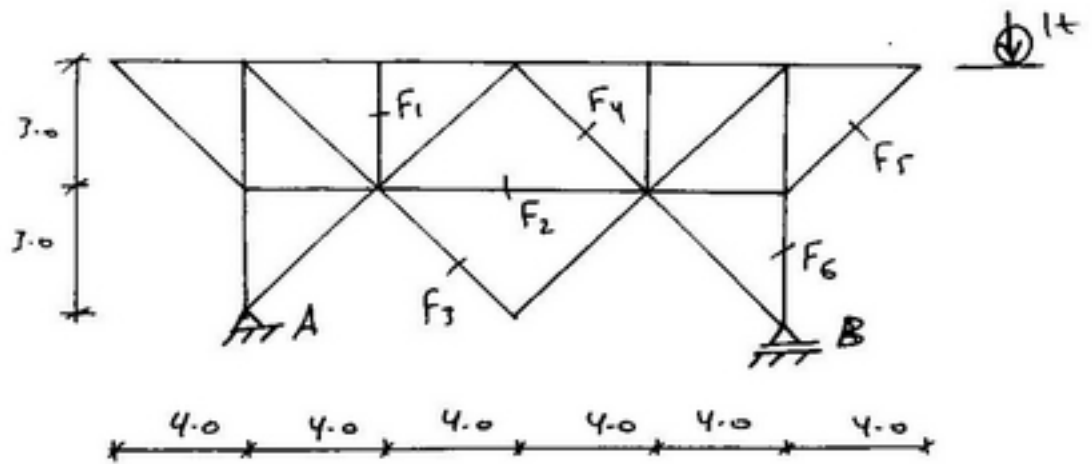
$$\Rightarrow F_6 \times 0.8 = y_a$$

(3)

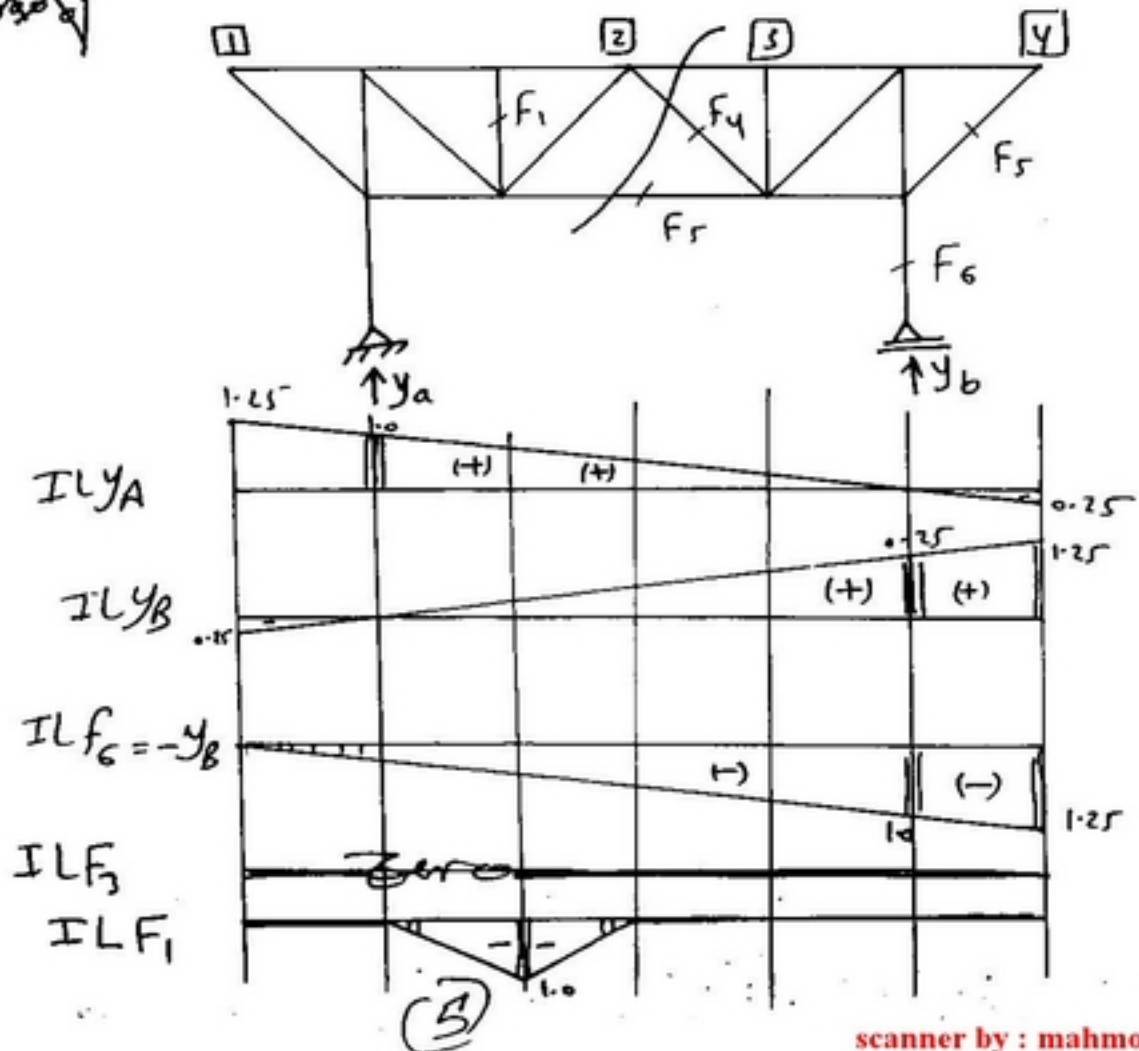
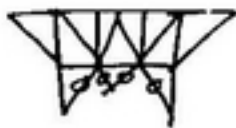
$$\Rightarrow \boxed{F_6 = 1.25 y_a}$$



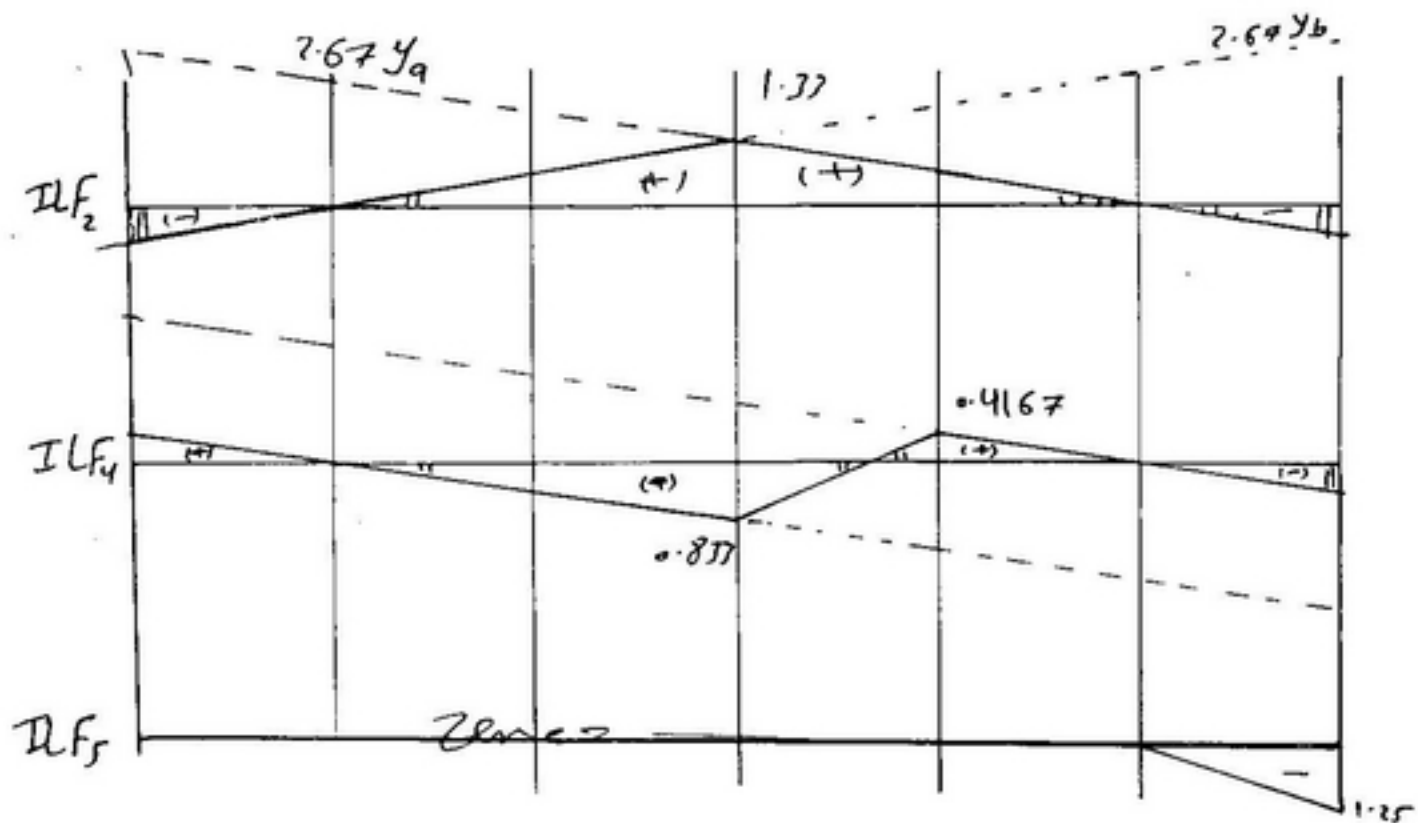
Final 2007



—Sol—





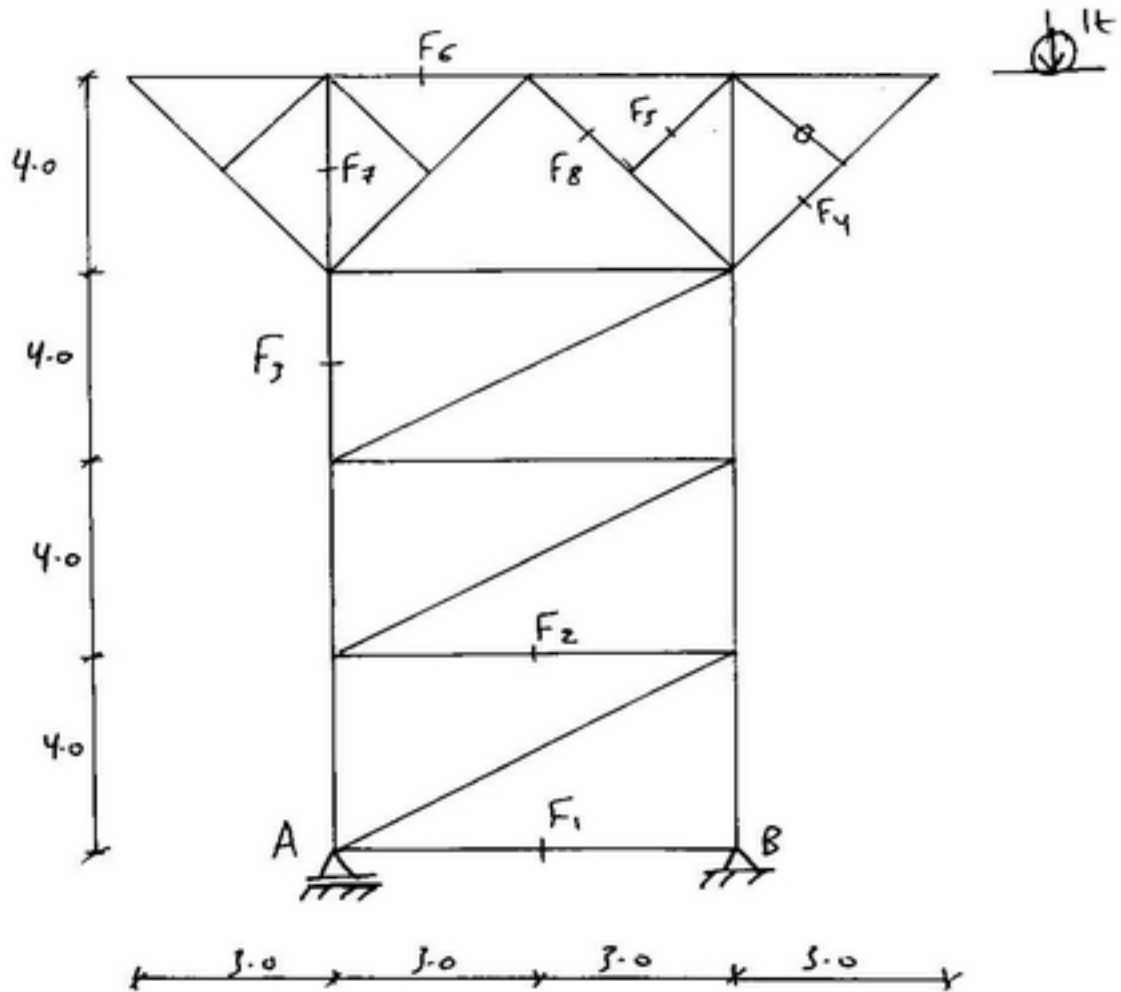


نیز که = صفر



(7)

final 2004

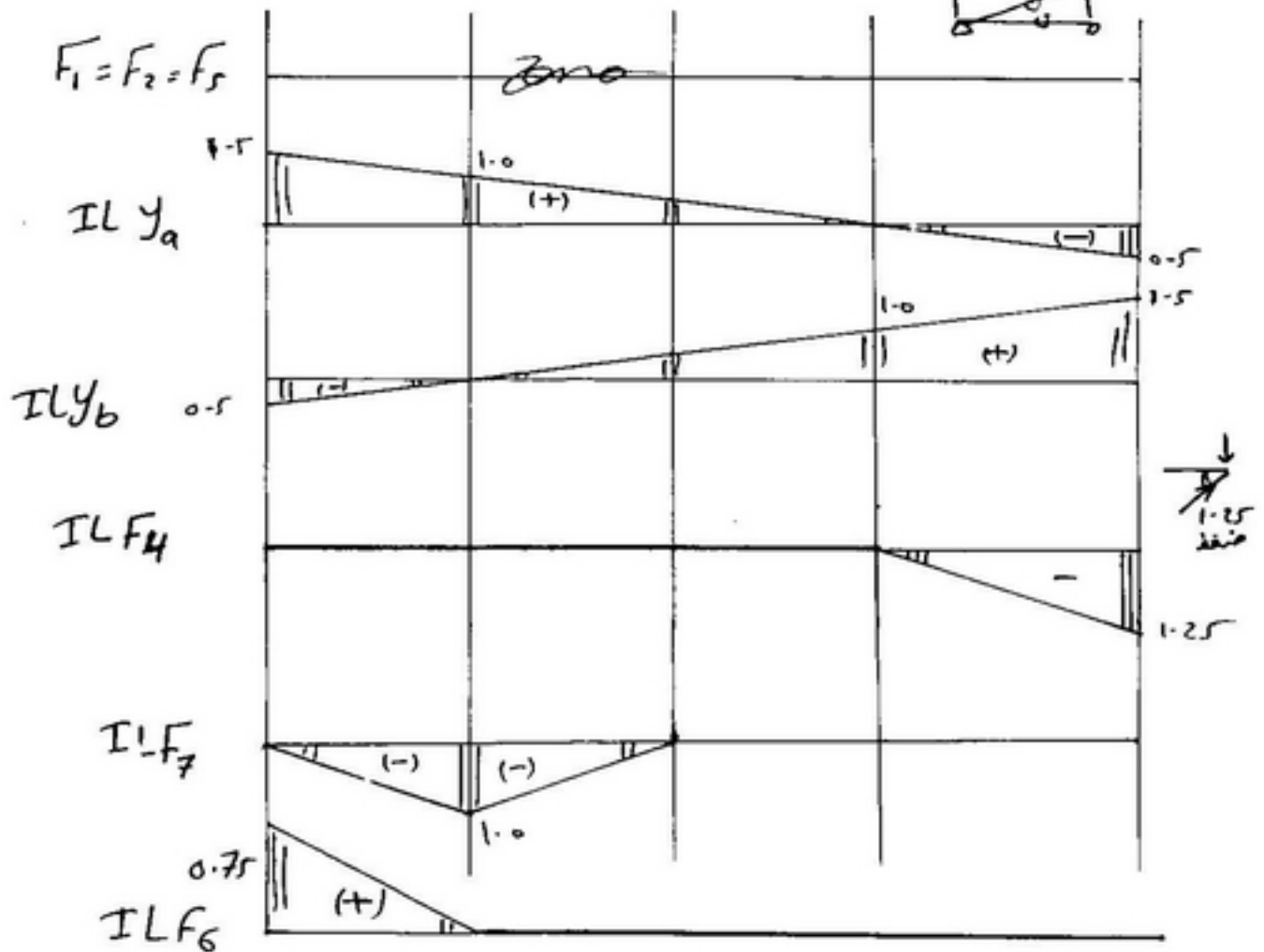
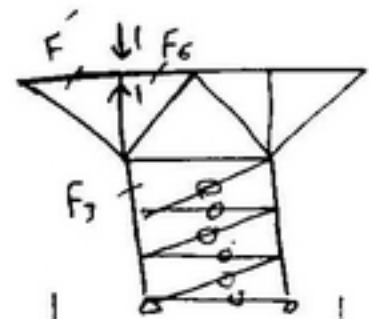


draw IL  $y_A$ ,  $y_B$  and Internal  
Force

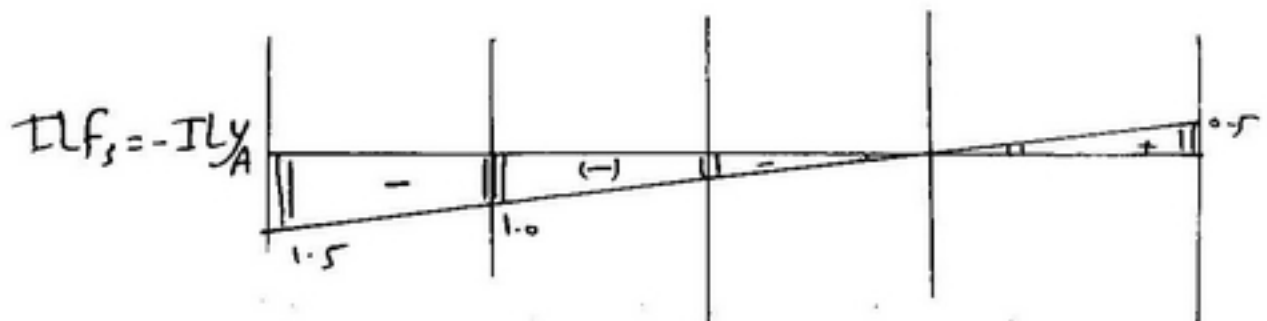
(8)



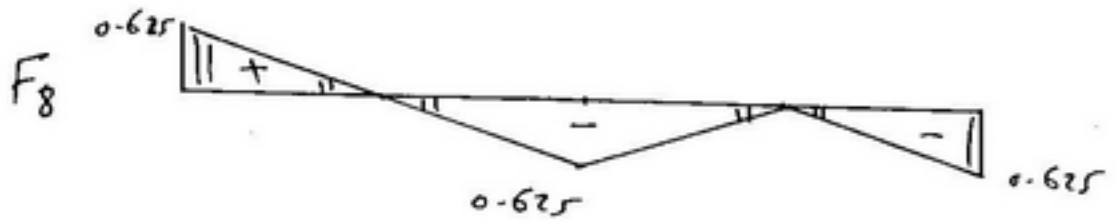
$F_5, F_1, F_2$  Zero member



$$F_6 = F' \quad F' \Rightarrow 1.25 \times 0.6 = 0.75$$



$$F_{or} \rightarrow F_8$$



Zagazig University  
 Faculty of Engineering  
 1<sup>st</sup> Year Civil Eng.  
 Full Marks: 90 Marks

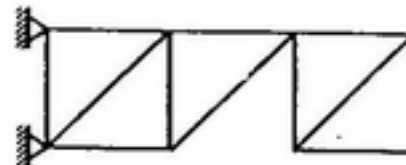
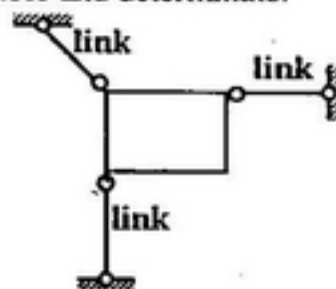
Assume Any  
 Missing Data

Structural Analysis  
 Final Term Examination  
 Date: 21/1/ 2007.  
 Time Allowed: 3 Hours

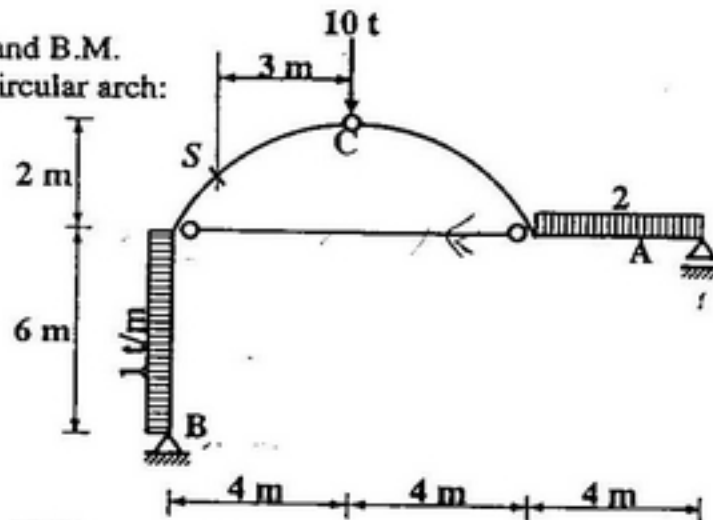
**Attempt All problems:**

**PROBLEM NO. (1): (20 MARK)**

- a) Check the stability and determinacy for the given structures. If they are unstable or statically indeterminate, show how they can be modified to become stable and determinate.

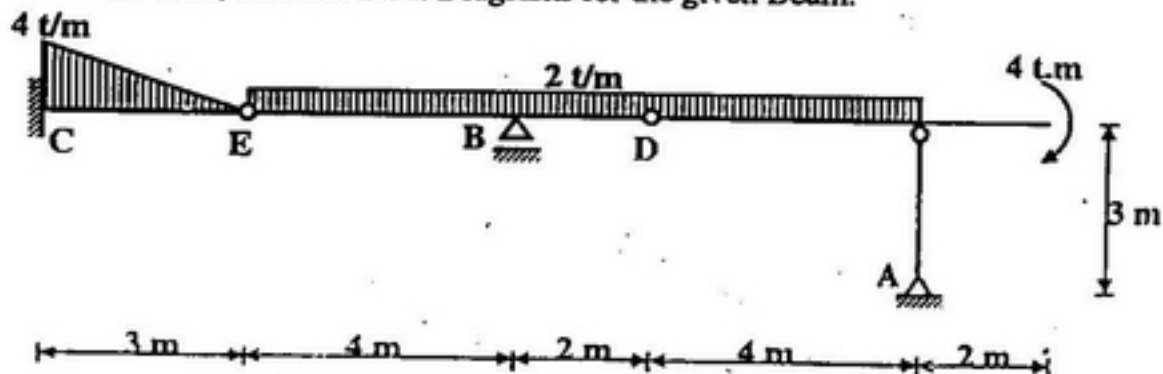


- b) Calculate the N.F., S.F. and B.M. at section (S) in the given circular arch:



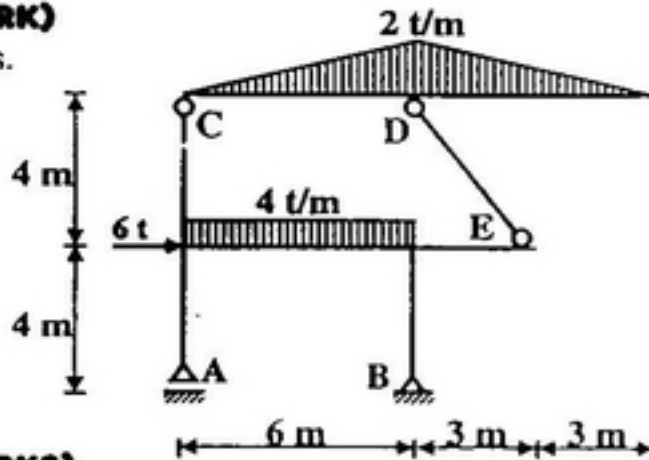
**PROBLEM NO. (2): (16 MARK)**

Draw the N.F., S.F. and B.M. Diagrams for the given Beam:

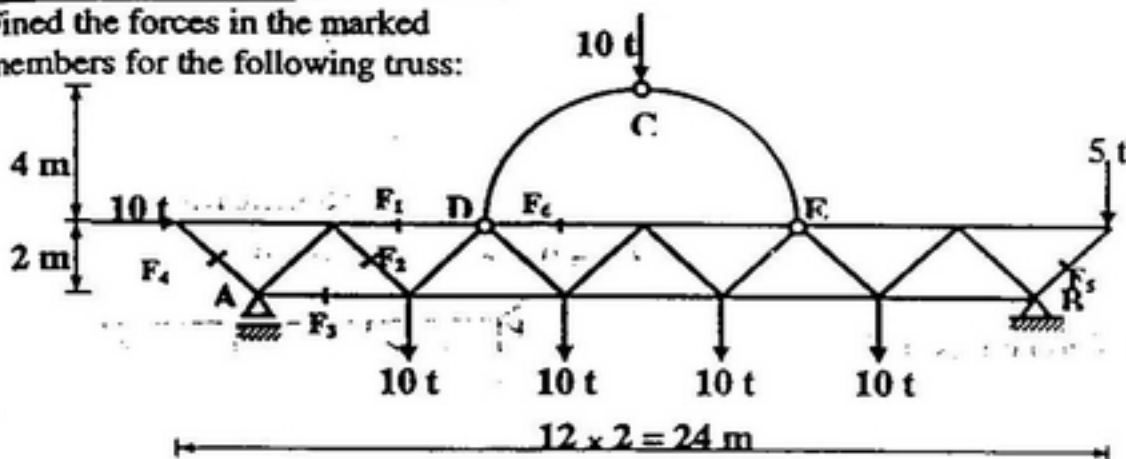


**PROBLEM NO. (3): (19 MARK)**

Draw the N.F., S.F. and B.M.Ds.  
for the given Frame:

**PROBLEM NO. (4): (19 MARKS)**

Find the forces in the marked  
members for the following truss:

**PROBLEM NO. (5): (18 MARKS)**

a) Draw the influence lines

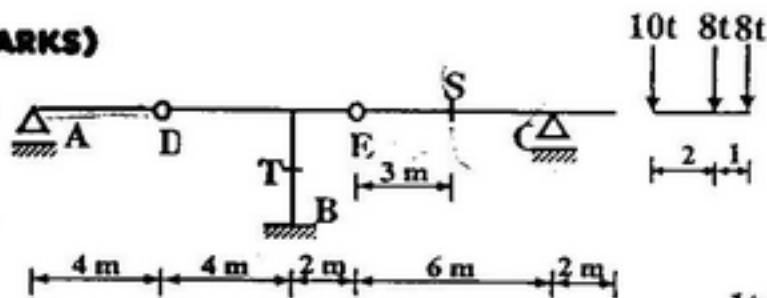
of  $Y_A$ ,  $Y_B$ ,  $Y_C$ ,  $Q_{CL}$

$M_B$ ,  $M_C$ ,  $Q_S$  and  $M_S$ .

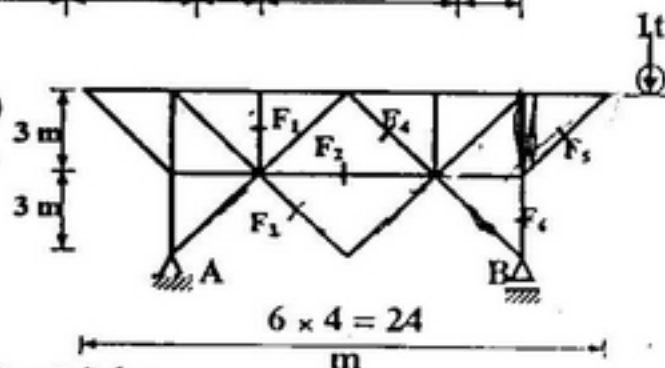
b) Determine the max.

$Q_S$  due to the given

loading system:

**PROBLEM NO. (6): (16 MARKS)**

Draw the influence lines of  $Y_A$ ,  $Y_B$ ,  
and the Forces in the marked  
members for the Shown Truss:



Best Wishes,

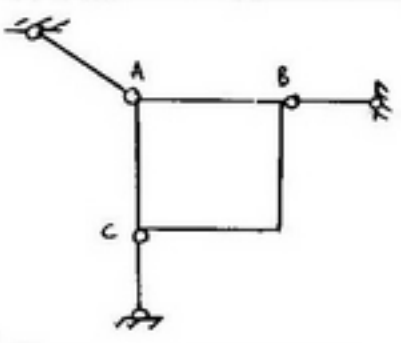
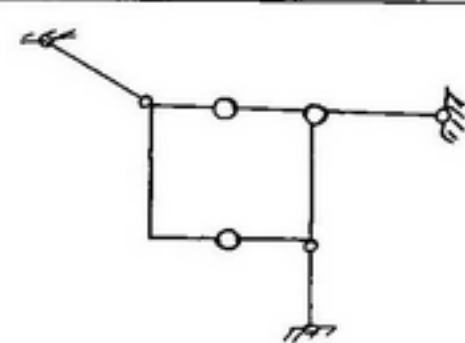
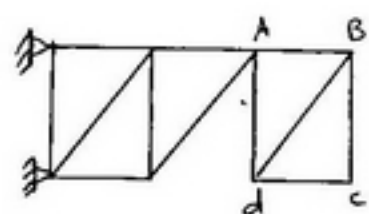
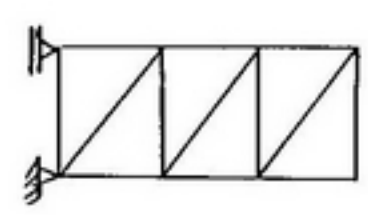
Prof. Dr. Ashraf M. El-Shihy

Prof. Dr. Hesham F. Shaat

Dr. Tarek M. Amin

Final 2007

a) check the stability

Structure	Status	modification
	<p>Unstable</p> <p>كل احدى الزوايا (A) متحركة</p>	
	<p>Unstable</p> <p>كل احدى الزوايا ABCD متحركة</p>	

b)

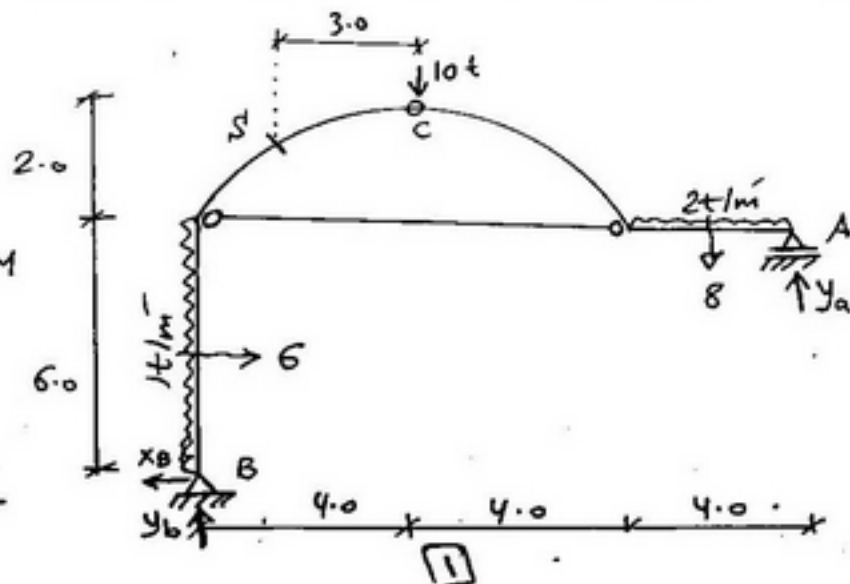
R<sub>eq</sub>

N.F.D, S.F.D, B.M

at section (S)

in the given

Circular Arch



-Sol-

Reactions

$$* \sum X = 0.0$$

$$\Rightarrow X_B = 6 \text{ ton.}$$

$$* \sum M_B = 0.0$$

$$3 \times 6 + 10 \times 4 + 8 \times 10 = Y_a \times 12$$

$$Y_a = 11.5 \text{ ton.}$$

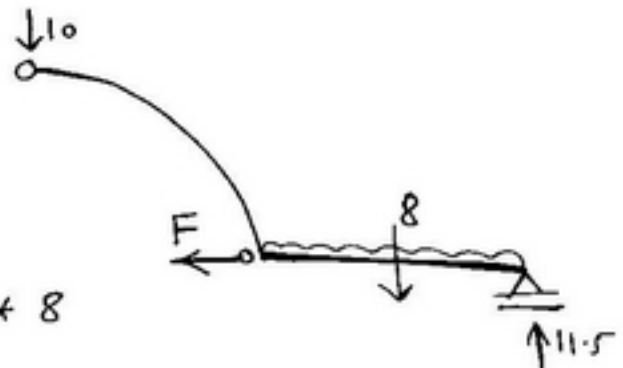
$$* \sum Y = 0.0$$

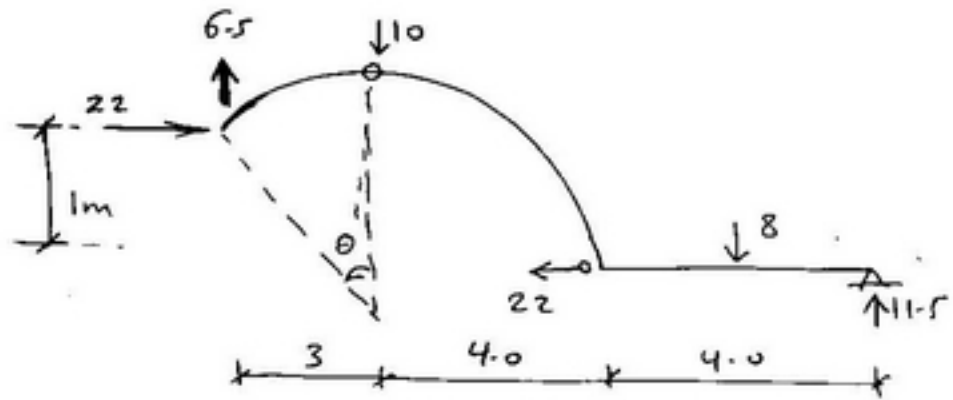
$$Y_b = 10 + 8 - 11.5 = 6.5 \text{ ton}$$

$$* \sum M_{C_R} = 0.0$$

$$8 \times 6 + F \times 2 = 11.5 \times 8$$

$$F = 22 \text{ ton.}$$





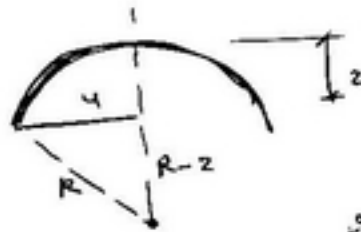
for R

$$R^2 = 4^2 + (R-2)^2$$

$$R^2 = 16 + R^2 - 4R + 4$$

$$4R = 20$$

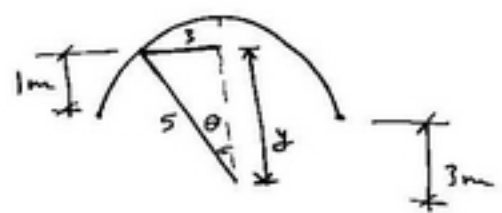
$$R = 5m$$



$$\therefore R-2 = 3.0m$$

$$\theta = \sin^{-1}(3/5) = 36.87^\circ$$

$$y = \sqrt{5^2 - 3^2} = 4m$$

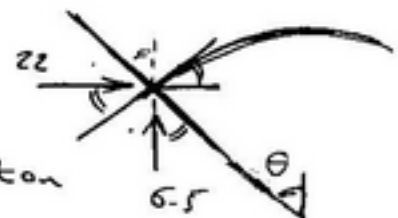


$$M_R = 11.5 \times 11 - 8 \times 9 - 22 \times 1 + 10 \times 3$$

$$= 2.5 \text{ t.m}$$

$$N_S = 22 \cos \theta + 6.5 \sin \theta$$

$$= [22 \times 0.8 + 6.5 \times 0.6] = 21.5 \text{ ton}$$

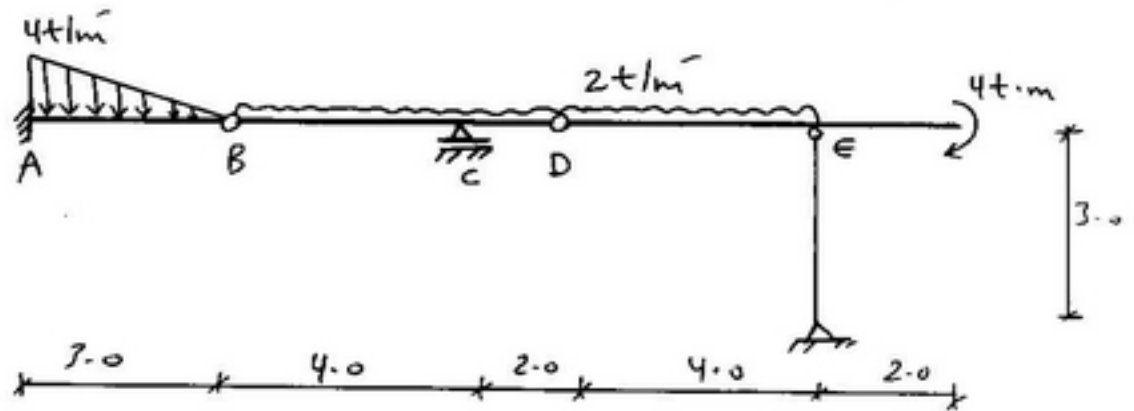


$$Q_S = 6.5 \times 0.8 - 22 \times 0.6$$

$$= -8 \text{ ton}$$

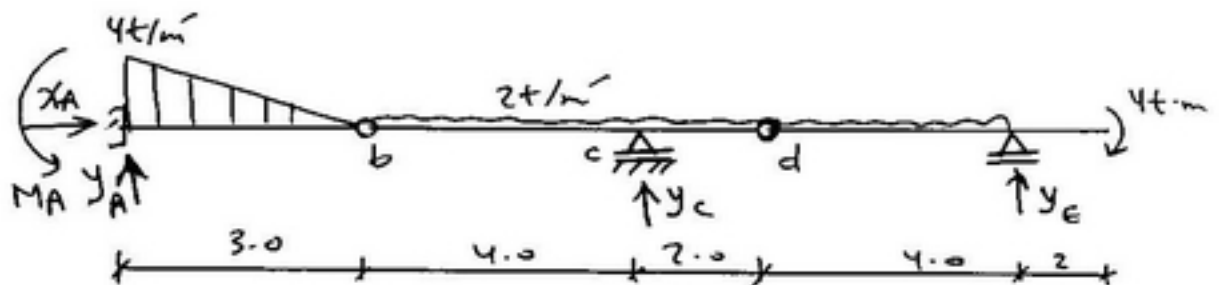
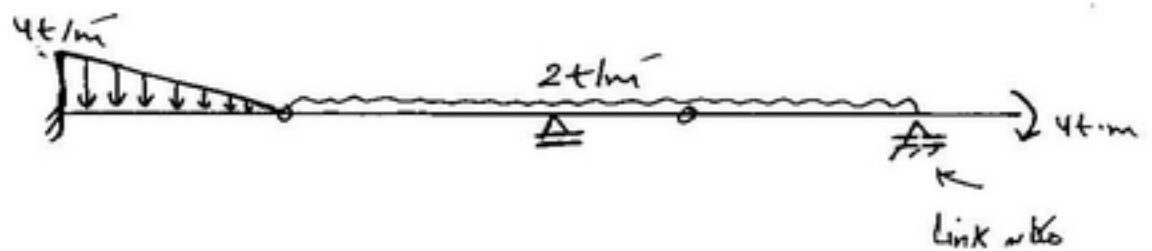


# Problem ②



draw B.M.D, S.F.D, N.F.D

———— sol ————



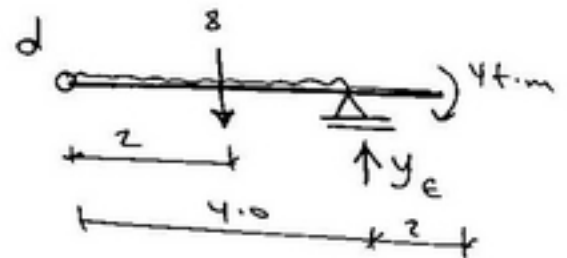


## Reactions

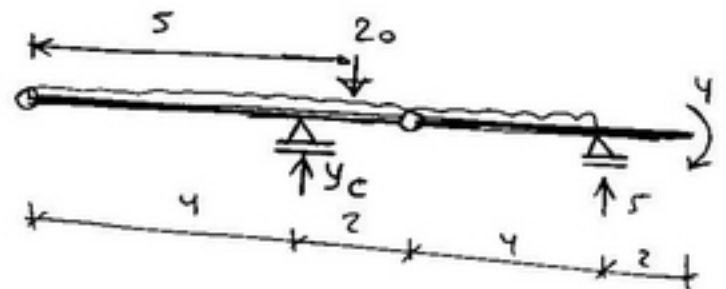
$$\Rightarrow * \underline{\Sigma M_{dR} = 0.0}$$

$$8 \times 2 + 4 = y_e \times 4$$

$$\boxed{y_e = 5 \text{ ton}}$$



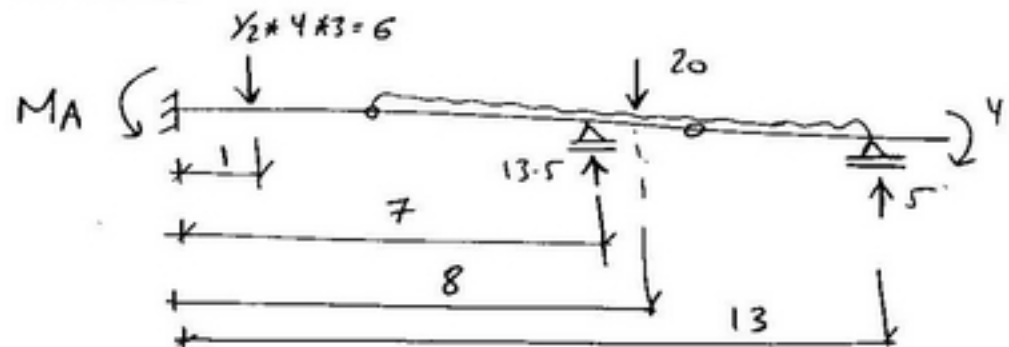
$$\Rightarrow * \underline{\Sigma M_{bR} = 0.0}$$



$$20 \times 5 + 4 - y_c \times 4 = 0$$

$$\Rightarrow y_c = 13.5 \text{ ton}$$

$$\Rightarrow * \underline{\Sigma M_A = 0.0}$$



$$M_A = 6 \times 1 + 20 \times 8 + 4 - 13.5 \times 7 - 5 \times 13$$

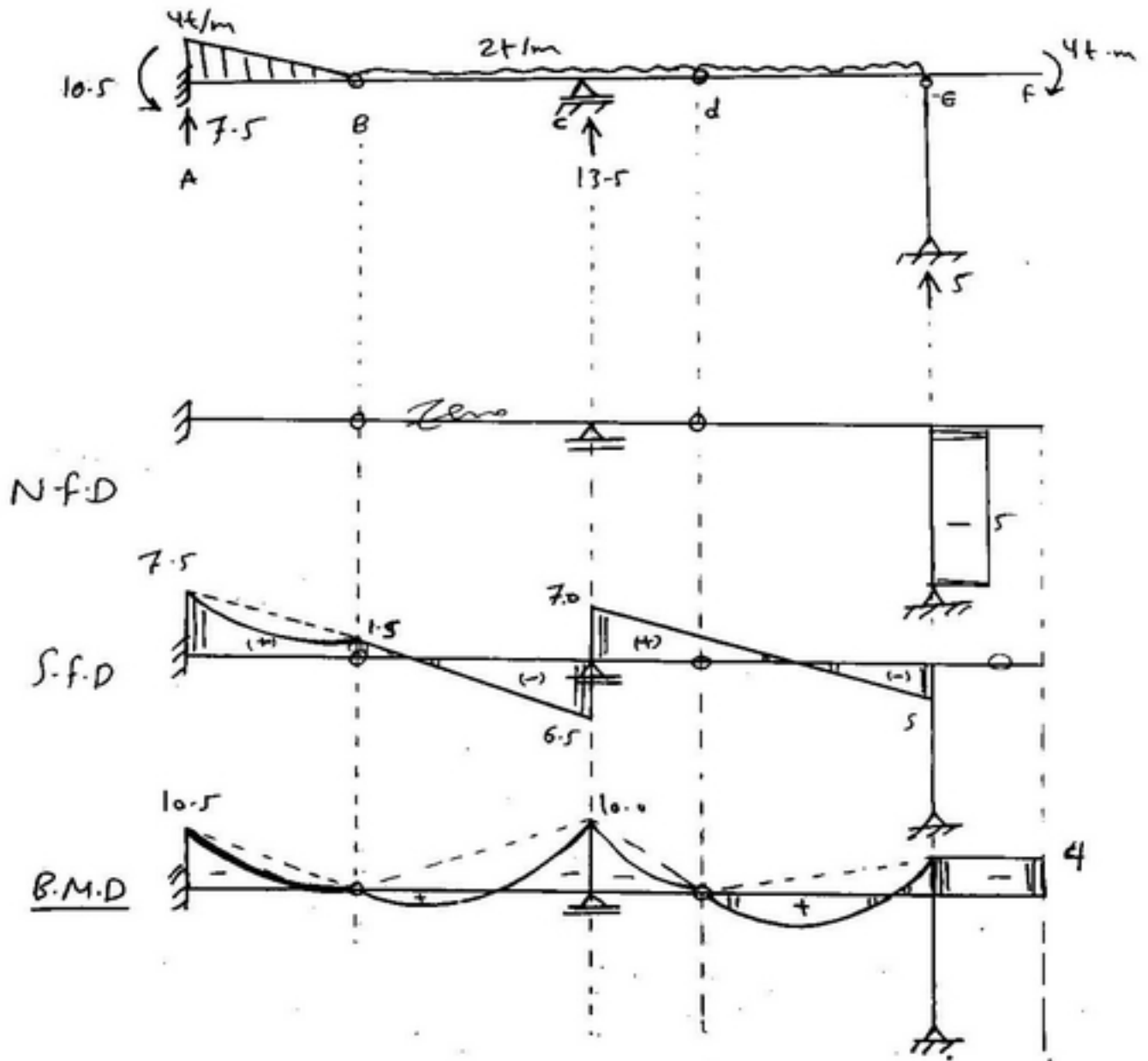
$$= 10.5 \text{ t.m}$$

$$\Rightarrow \sum X = 0.0$$

$$X_A = 0.0$$

$$\Rightarrow \sum Y = 0.0$$

$$Y_A = 6 + 20 - 13.5 - 5 = 7.5 \text{ ton}$$



لرسم - 5-6-0

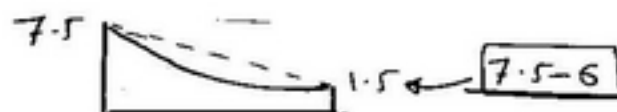
نبدأ كند A

1- خب حمل (7.5) لائل نطلع بييه .

2- من A ← B خب حمل مثلث بيكونه shear منية منين  
بيكونه حلقه تحت لحظ لحظ لائل لانه ساقص .

منزل من 7.5 منية لل (لوز) = 6

$$7.5 - 6 = 1.5$$



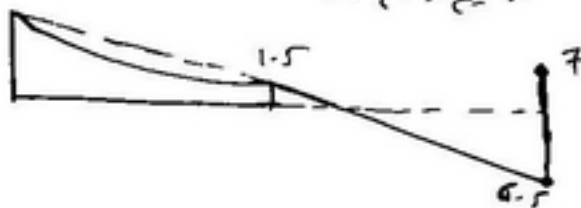
3- من B ← C خب حمل موزع 2t/m

$$8t = 2 \times 4 = \text{مقدار تركيز}$$

ربالتال منزل من B ← C 8t

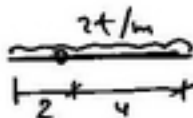
$$\text{تحت} = -6.5 = -8 - 1.5$$

منين وضع -6.5 كند C ورسويل B من C بخط مائل .



4- كند C يوجد حمل لائل 13.5 منين يتبع الطلوع 13.5 من

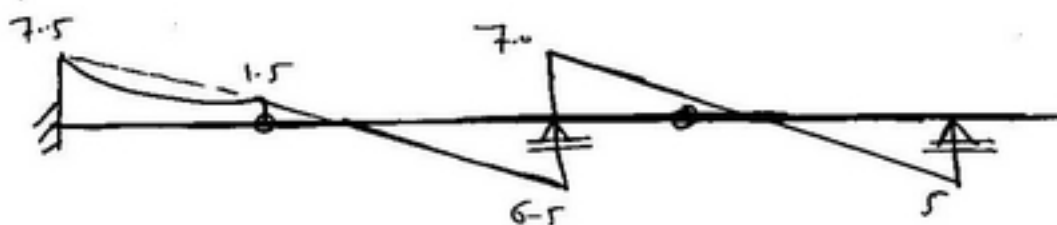
$$\text{منقطة} = 7 = -6.5 + 13.5$$

0- م  $\Leftarrow C \Leftarrow E$  لا يوجد سوى حمل  $\Leftarrow$  unifor  $\frac{2t}{m}$   


تر كيزه  $= 2 \times 6 = 12$  لا سفل .

$$\therefore 7 - 12 = -5$$

يتوضع (-5) كند  $E$  و تو ميل م  $-5 \rightarrow 7$   
 خط مائل .



7- كند  $E$  بند حمل  $5+$  لائل م  $\Leftarrow$  يتوقف الحمل .

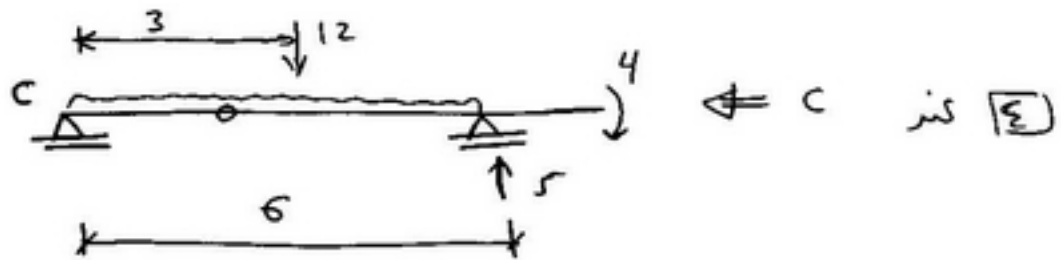
لرسم  $B.M.D$

II كند  $F \Leftarrow$  عزوم مركز منقطة  $5t.m$   
 ده بند ا ب  $4t.m$  منقطة

III كند  $E \Leftarrow$  ناخذ اعظم م ايسه  $4t.m$   
 ده اعظم يكونه  $4$  منقطة ايضا .

3] كند  $d \Leftarrow$  لغزم = صفر Intermediate

نقطه وصل 4  $\Leftarrow$  0 نقطه  
منطقه تعلیه Parabola



منطقه  $M_c = 12 \times 3 + 4 - 5 \times 6 = 10 \text{ t.m}$

نقطه وصل به 10  
نقطه 0  $\Leftarrow$  10  
نقطه منطقه تعلیه  
Parapola

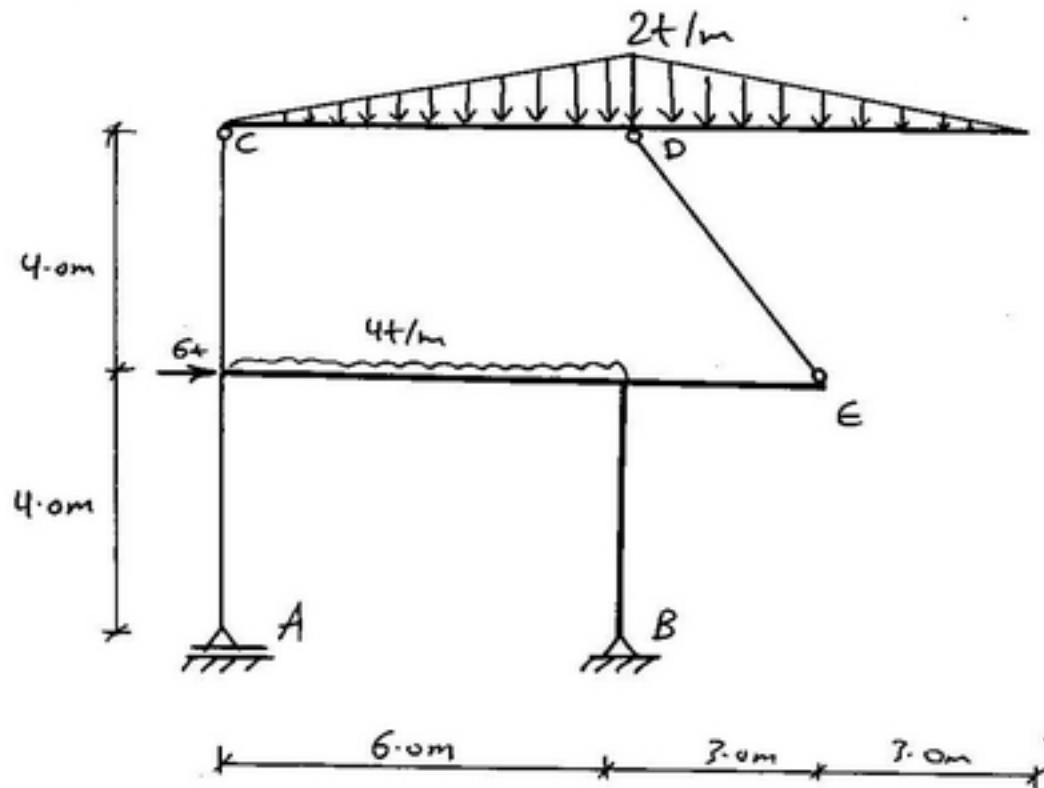


5] كند B لغزم = صفر نقطه وصل به 10  $\Leftarrow$  0  
نقطه منطقه تعلیه Parapola



7] كند A لغزم حسب Reaction = 10.5 منوطه نتيه

نقطه وصل به 10.5  $\Leftarrow$  10.5  
نقطه منطقه تعلیه Parapola

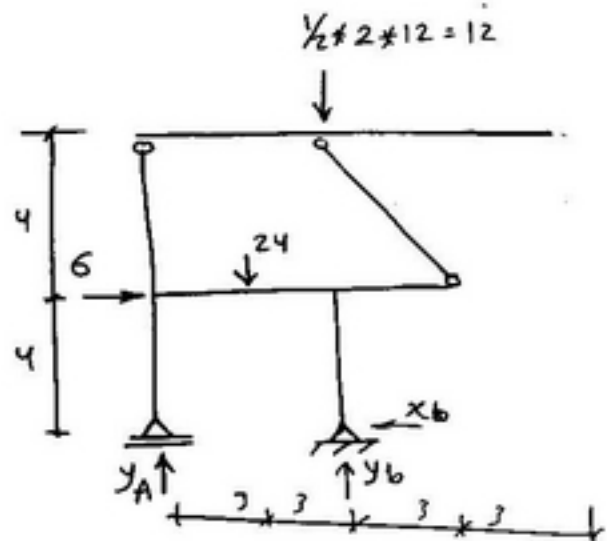
Prob (3)

for the following frame draw

N.F.D, S.F.D, M.D

— 502 —

For Reaction



$$\Rightarrow \underline{\sum X = 0}$$

$$X_b = 6 \text{ ton}$$

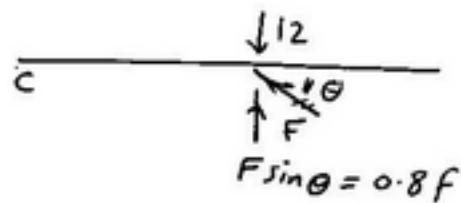
$$\Rightarrow \underline{M_A = 0.0}$$

$$6 \times 4 + 24 \times 3 + 12 \times 6 = 96 \times 6$$

$$y_b = 28 \text{ ton.}$$

$$\Rightarrow y = 0.0$$

$$y_a = 12 + 24 - 28 = 8 \text{ ton}$$

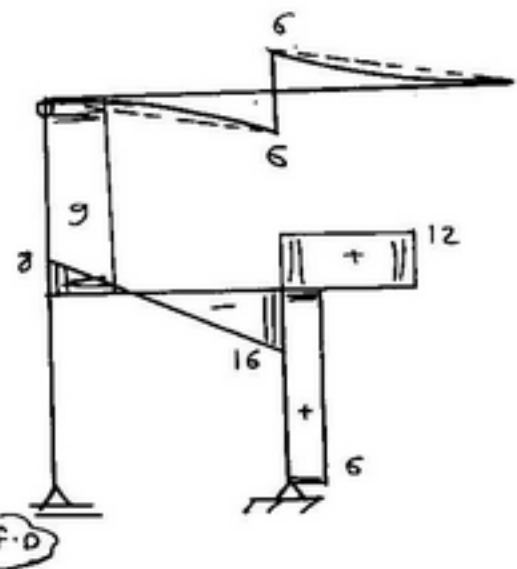
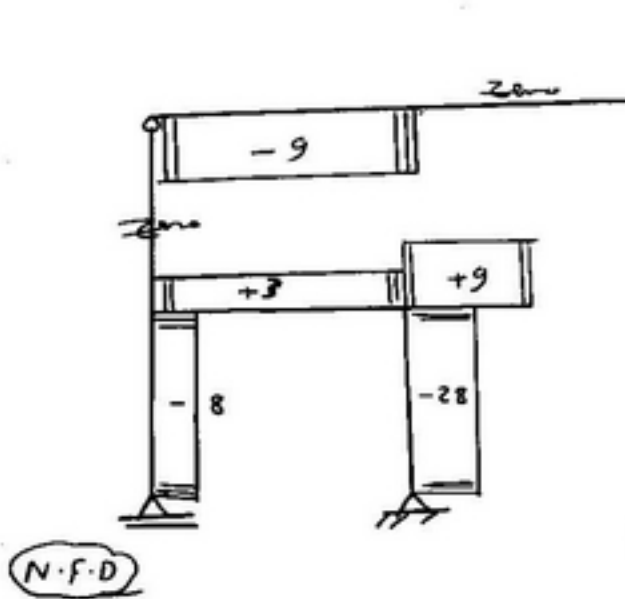
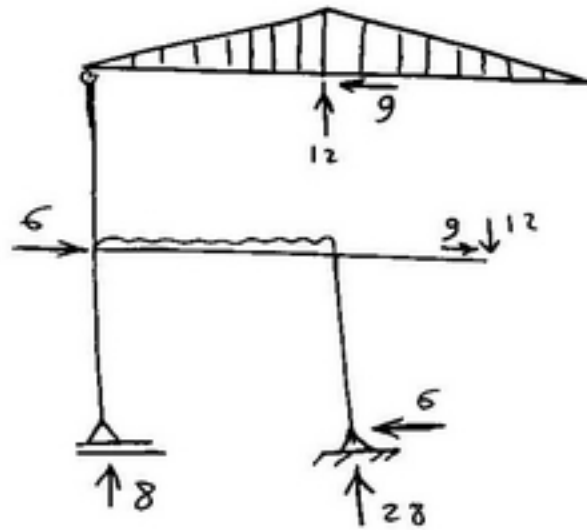
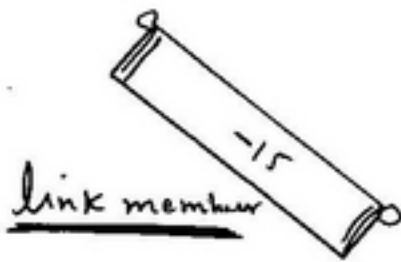
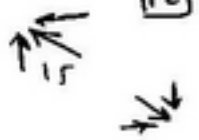


$$\Sigma M_{C_R} = 0.0$$

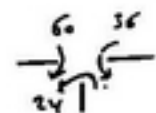
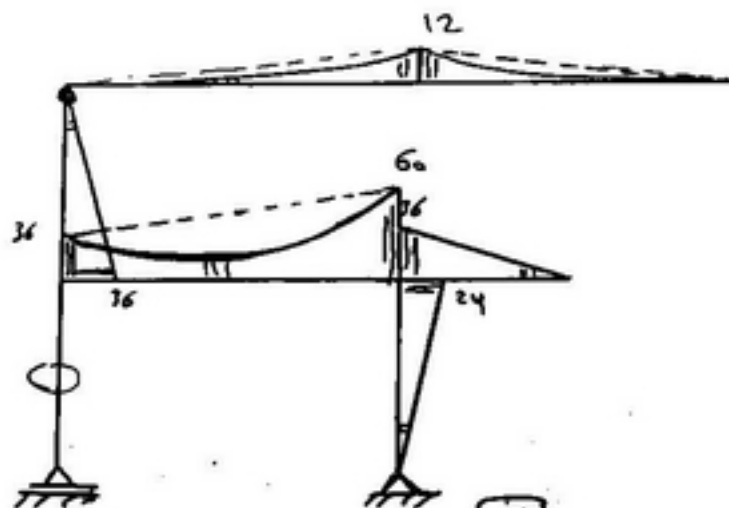
$$12 \times 6 = 0.8 F \times 5$$

$$F = 15 \text{ ton}$$

14

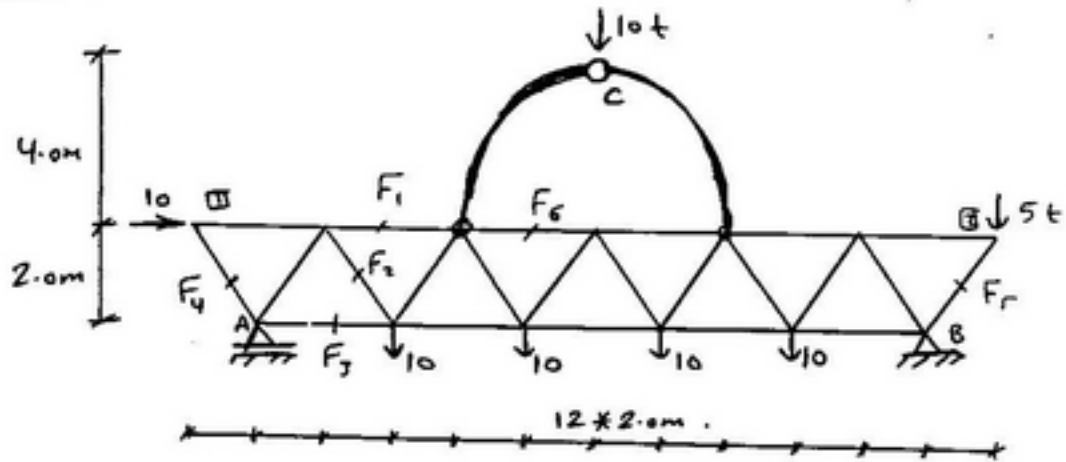


B.M.D



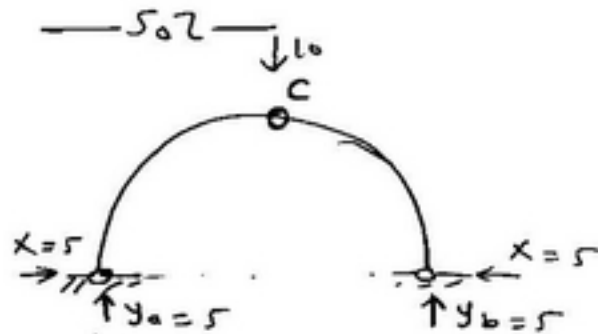


Prob (4)



Find the Internal forces  
In the marked member

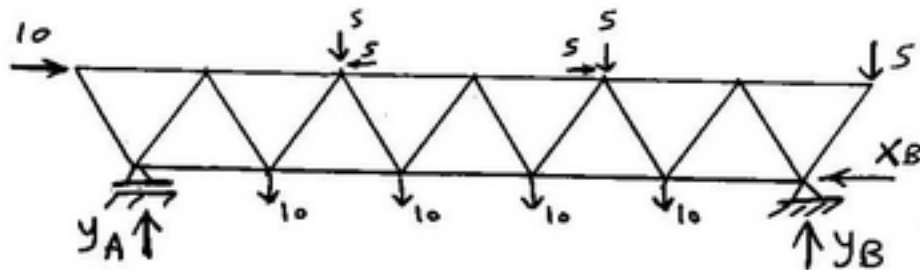
Arch Reaction  $\rightarrow$   $\leftarrow$  truss 10t



$$\sum M_{C_R} = 0$$

$$5 \times 4 = X \times 4$$

$$X = 5 \text{ t}$$



$$* \underline{\sum X = 0.0}$$

$$X_B = 10 \text{ ton.}$$

$$* \underline{\sum M_A = 0.0}$$

$$10 \times 2 + 10 \times 4 + 10 \times 8 + 10 \times 12 + 10 \times 16 + 5 \times 22 \\ + 5 \times 6 + 5 \times 14 = Y_B \times 20$$

$$\Rightarrow Y_B = 31.5 \text{ ton.}$$

$$* \underline{\sum Y = 0.0}$$

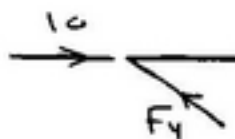
$$Y_A = 23.5$$

Forces

joint (1)

Zero

$$F_4 = 0.0$$



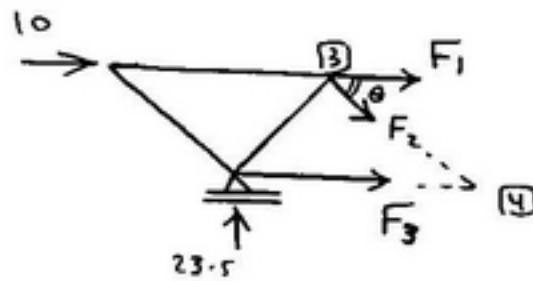
joint (2)

$$\sum Y = 0.0$$

$$5 = F_5 \cdot \sin \theta$$

$$F_5 = 5 / \sin 45 = 7.07 \text{ ton (2200 lb)}$$



Sec I

$$\Rightarrow \underline{\sum F_y = 0.0}$$

$$F_2 \sin \theta = 23.5$$

$$F_2 = 23.5 / \sin 45 = 33.23 \text{ ton} \quad (\text{دنيا})$$

$$\Rightarrow \underline{\sum M_3 = 0.0}$$

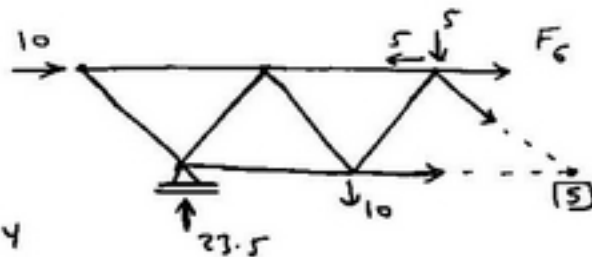
$$23.5 \times 2 = F_3 \times 2$$

$$F_3 = 23.5 \text{ ton} \quad (\text{دنيا})$$

$$\Rightarrow \underline{\sum M_4 = 0.0}$$

$$10 \times 2 + 23.5 \times 4 + F_1 \times 2 = 0.0$$

$$F_1 = -57 \text{ ton} \quad (\text{دنيا})$$

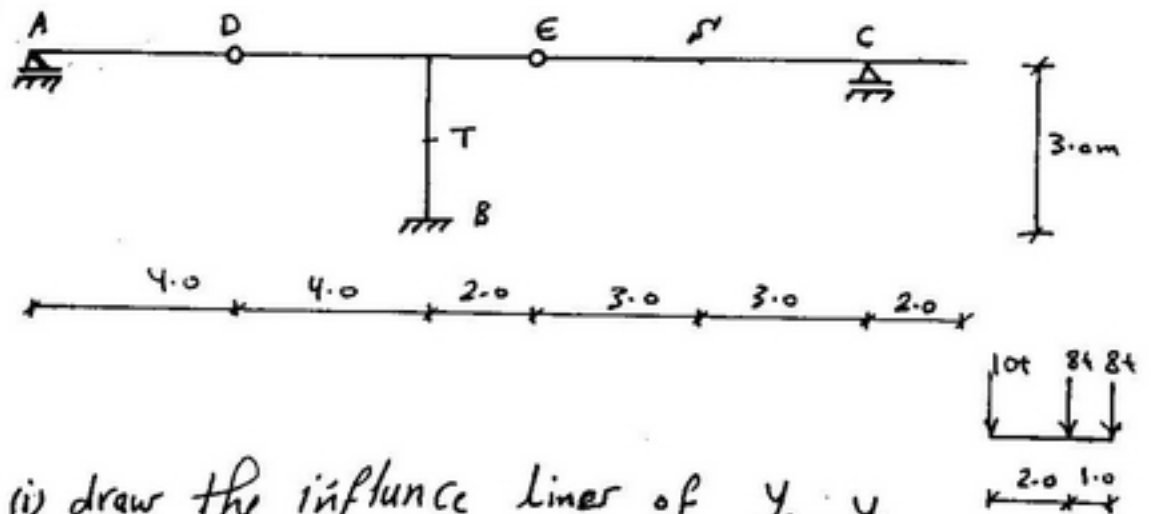
Sec II

$$\sum M_5 = 0.0$$

$$10 \times 2 + 23.5 \times 8 - 10 \times 4$$

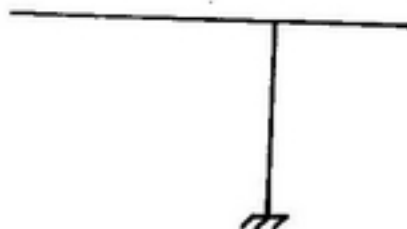
$$-5 \times 2 - 5 \times 2 + F_6 \times 2 = 0.0$$

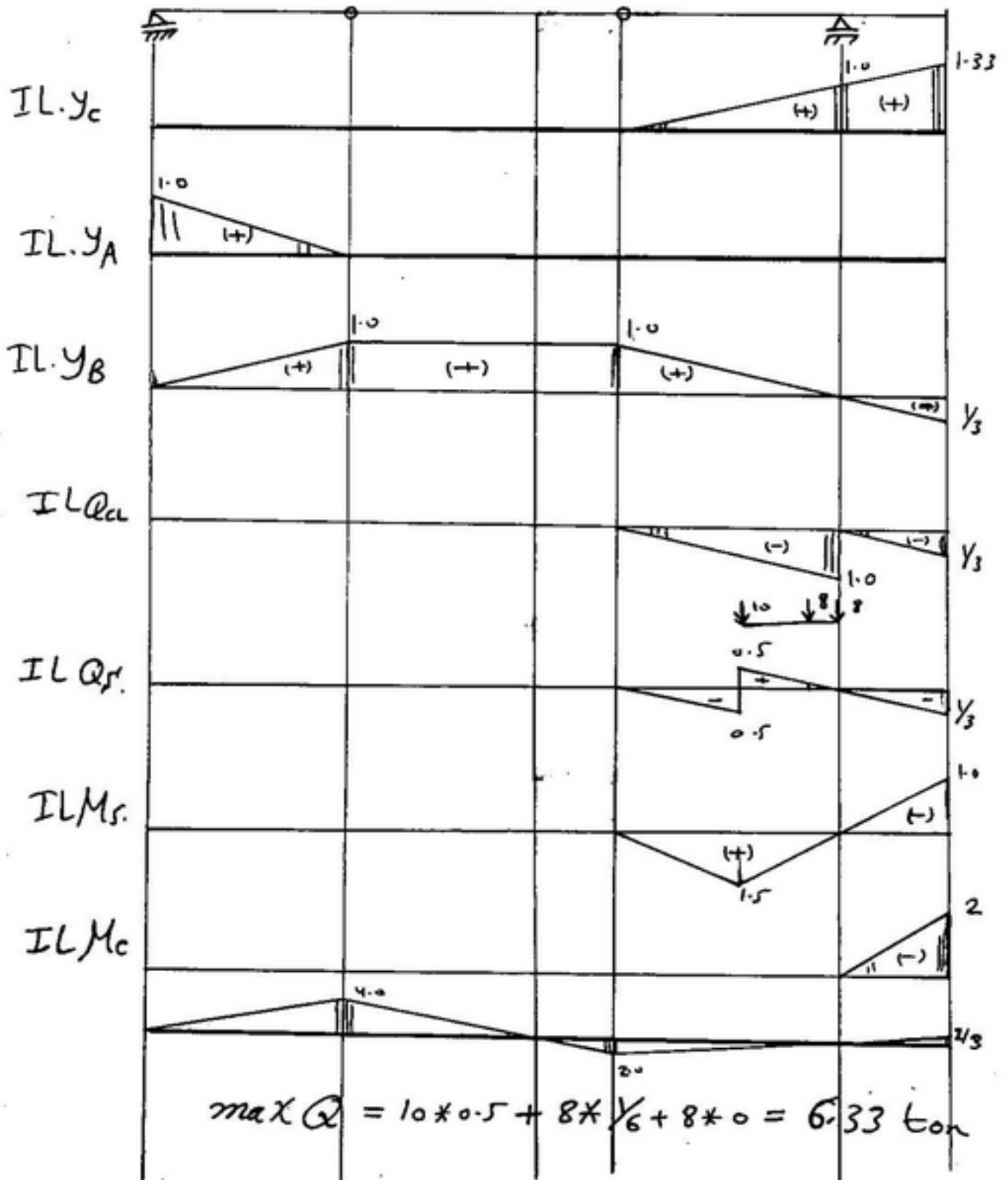
$$\Rightarrow F_6 = -74 \text{ ton} \quad (\text{دنيا})$$

Prob(5)

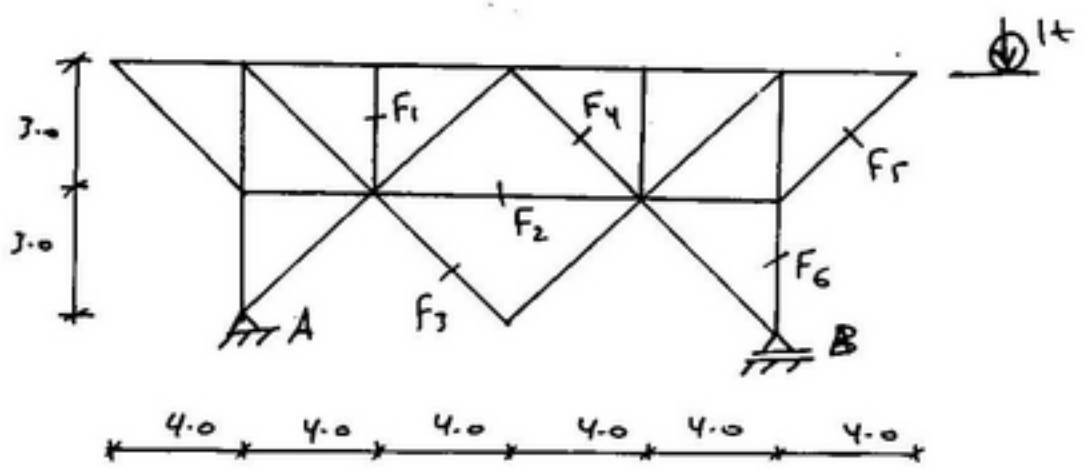
- (i) draw the influence lines of  $y_a, y_b, y_c, Q_L, M_B, M_C, Q_F$  and  $M_F$
- (ii) determine the max  $Q_F$  due to the given Loading system.

————— Sol —————

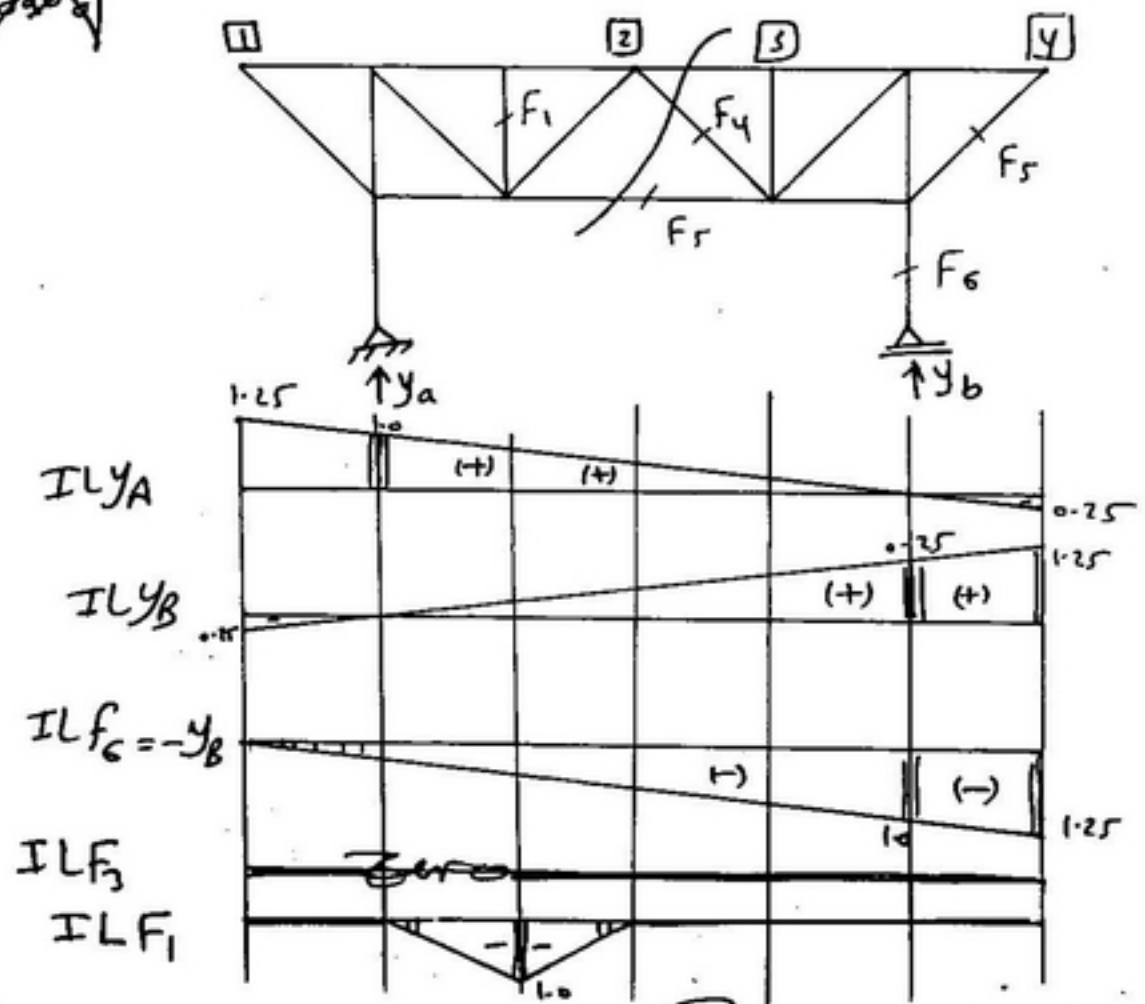
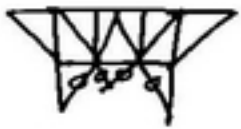




Final 2007

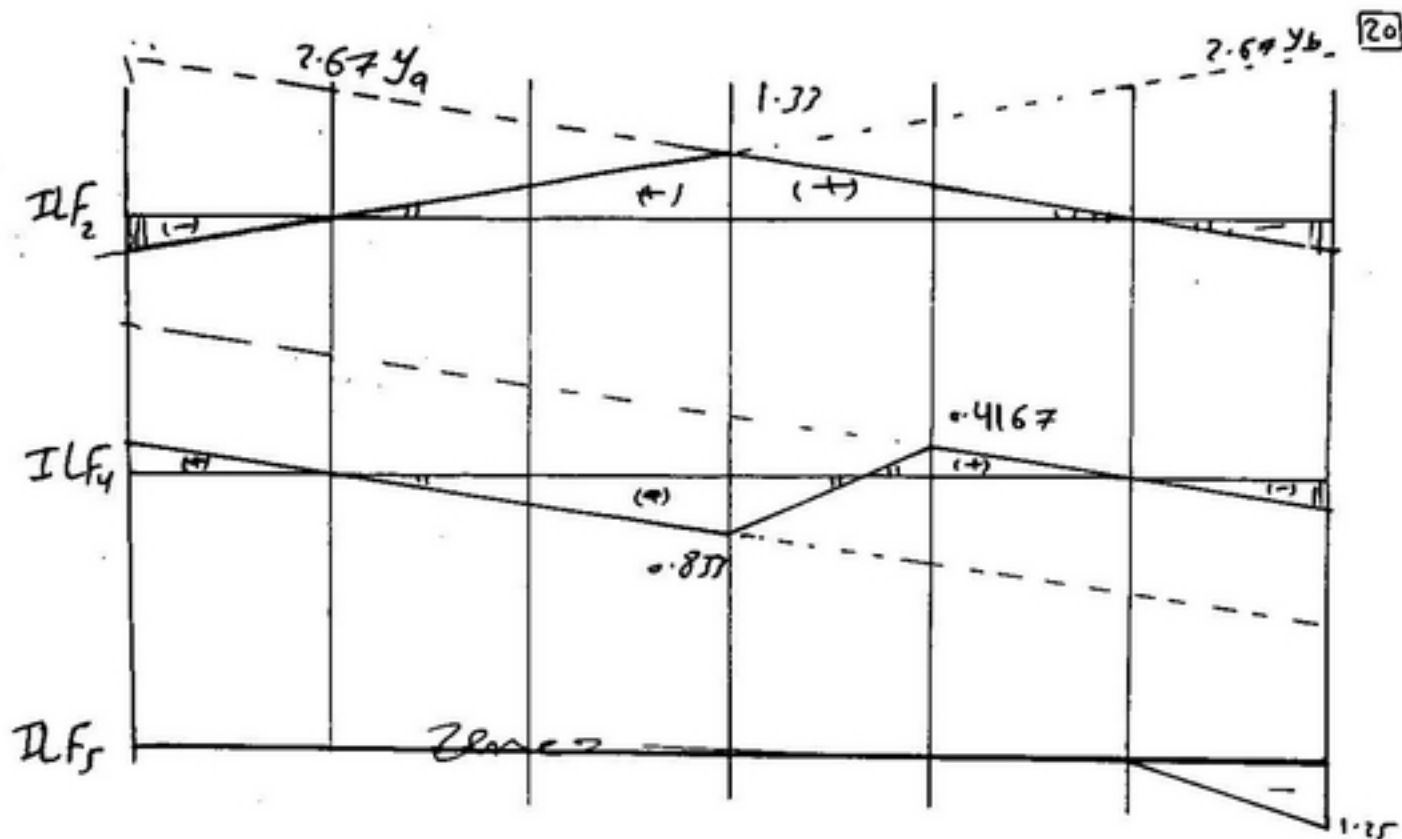


—Sol—

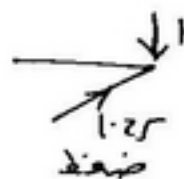


(18)





نیز کره = 1.25





January, 2006

Zagazig University  
Faculty of Engineering  
1<sup>st</sup> Year Civil Eng.  
Full Marks: 90 Marks

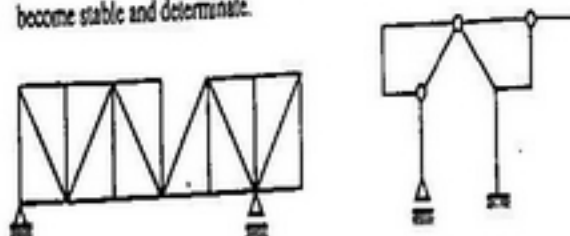
Assume Any  
Missing Data

Structural Analysis  
Final Term Examination  
Date: 18/1/2006.  
Time Allowed: 3 Hours

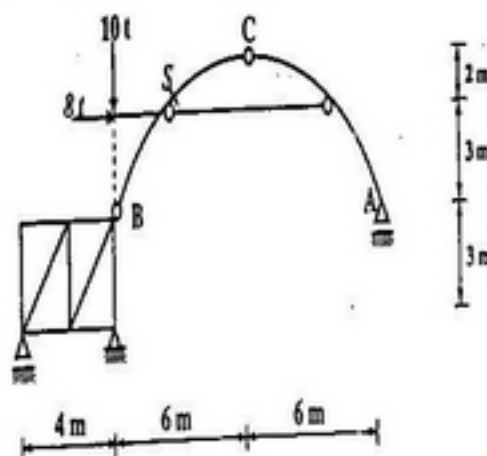
Attempt All problems:

**PROBLEM NO. (1): (20 MARK)**

- a) Check the stability and determinacy for the given structures. If they are unstable or statically indeterminate, show how they can be modified to become stable and determinate.

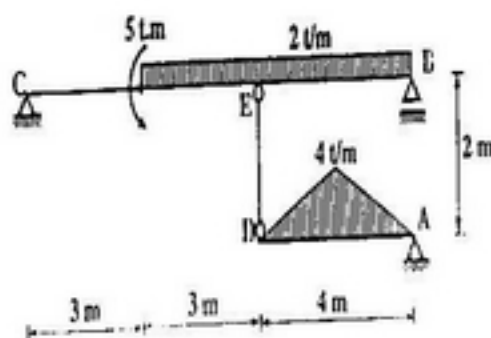


- b) Calculate the N.F., S.F. and B.M. at section (S) in the given parabolic arch:



**PROBLEM NO. (2): (16 MARK)**

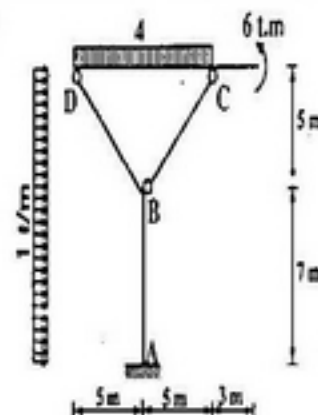
Draw the N.F., S.F. and B.M. Diagrams for the given Beam:



January, 2006

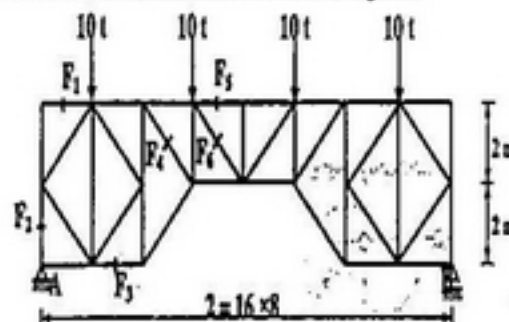
**PROBLEM NO. (3): (16 MARK)**

Draw the N.F.S.F. and B.M.Ds.  
for the given frame:



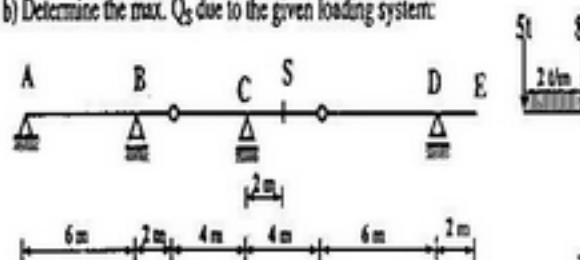
**PROBLEM NO. (4): (12 MARKS)**

Find the forces in the marked members for the following truss:



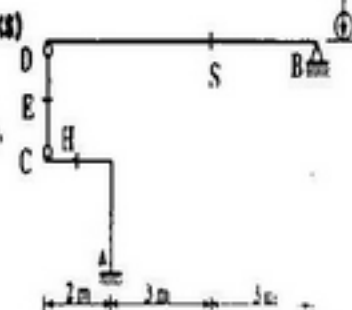
**PROBLEM NO. (5): (20 MARKS)**

- a) Draw the influence lines of  $Y_A$ ,  $Y_B$ ,  $Y_C$ ,  $Y_D$ ,  $Q_B$ ,  $Q_C$ ,  $M_B$ ,  $Q_5$  and  $M_5$  for the Shown Beam:  
b) Determine the max.  $Q_5$  due to the given loading system:



**PROBLEM NO. (6): (16 MARKS)**

Draw the influence lines of  
 $Y_A$ ,  $Y_B$ ,  $Y_D$ ,  $M_A$ ,  $Q_1$ ,  $M_5$ ,  $N_5$ ,  $Q_H$ ,  
for the Shown Frame:



Best Wishes,

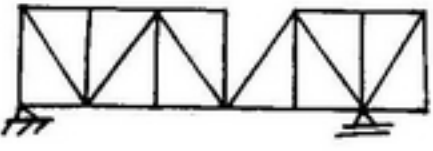
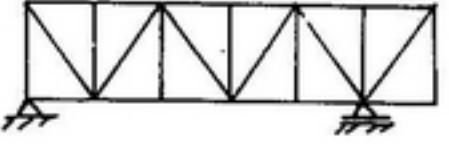
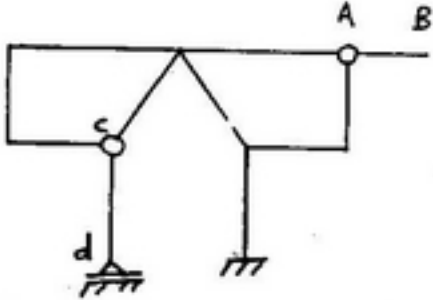
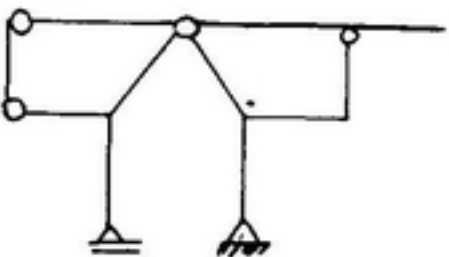
Prof. Dr. Ashraf M. El-Shahy

Prof. Dr. Mohamed S. Shaaban

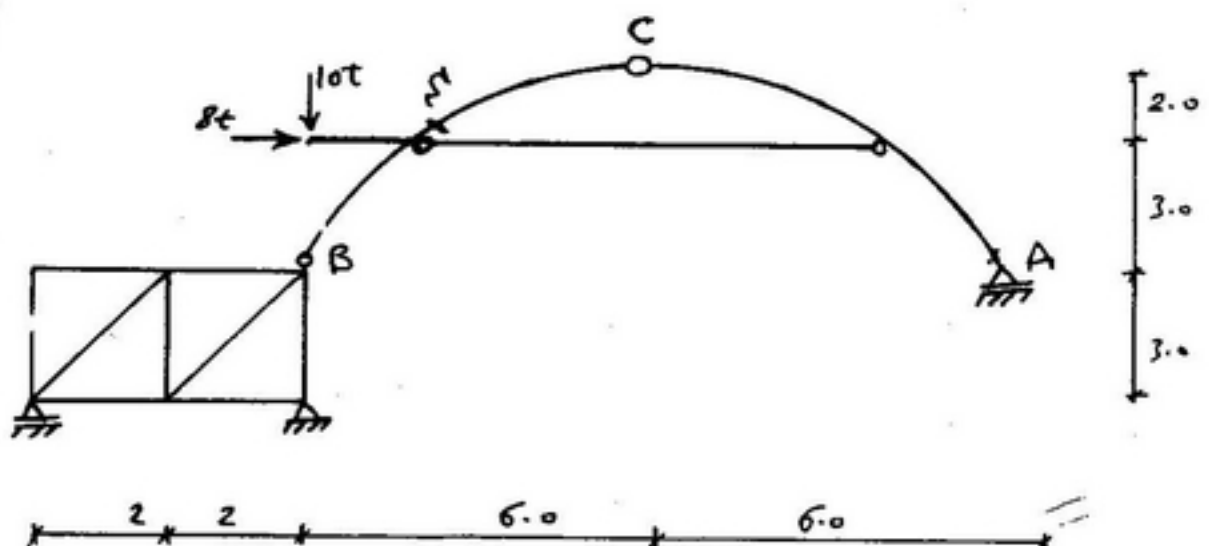
Dr. Tarek M. Amer

Solved Final 2006 = 15

a) check the stability

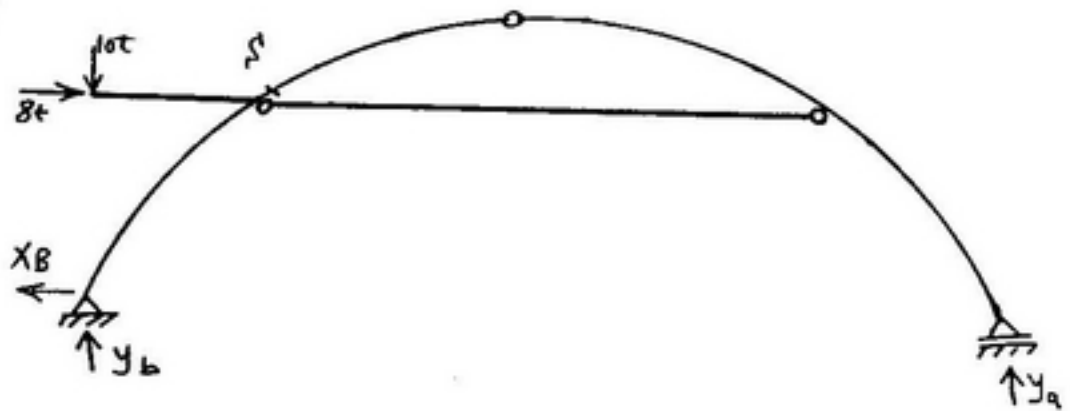
the given structure.	state	modification.
<p>1)</p> 	<p><u>unstable</u></p> <p>4 → معاكس 3 → مجاهيل</p>	
<p>2)</p> 	<p><u>unstable</u></p> <p>AB &amp; cd ↳ unstable</p>	<p>بعد تفليح لكل ليكو stable بغيره كل عند امقوله به (ر) باهليل يتبع وضع Int</p> 

b)



(2)

## Reactions



$$\underline{\Sigma M_b = 0.0}$$

$$8 \times 3 = Y_A \times 12$$

$$Y_A = 2 \text{ ton}$$

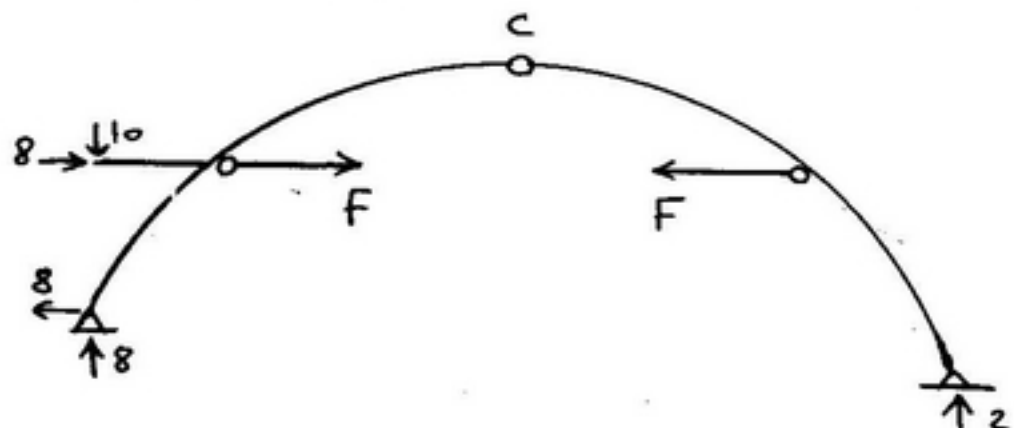
$$\underline{\Sigma Y = 0.0}$$

$$Y_B + 2 = 10$$

$$Y_B = 8 \text{ ton}$$

$$\underline{\Sigma X = 0.0}$$

$$X_B = 8 \text{ ton}$$

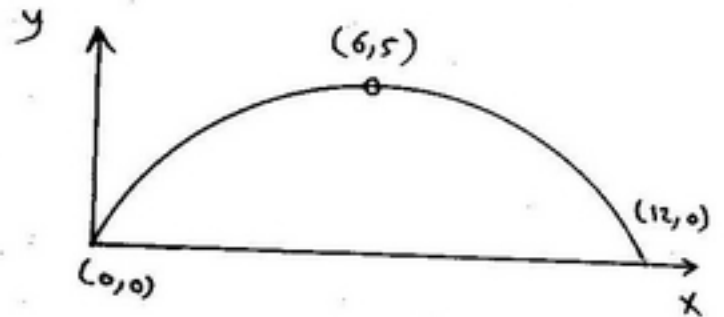


$$\underline{\Sigma M_{C_R} = 0.0}$$

$$2 \times 6 = 2F \rightarrow F = 6 \text{ ton.}$$

(3)

For eqn of Parabolic Arch



$$y = ax^2 + bx + c$$

at  $x = 0, y = 0$

$$0 = 0 + 0 + c \Rightarrow c = 0$$

at  $x = 12, y = 0$

$$0 = a(12)^2 + b(12)$$

$$\Rightarrow b = -12a$$

at  $x = 6, y = 5$

$$5 = a(6)^2 + (-12a)(6)$$

$$a = -\frac{1}{7.2}$$

$$\therefore b = 1.67$$

$$\therefore \boxed{y = -\frac{x^2}{7.2} + 1.667x}$$

$$\text{at } s' \Rightarrow y = 3$$

$$\Rightarrow 3 = -\frac{x^2}{7.2} + 1.667x$$

$$-x^2 + 12x = 21.6$$

$$\therefore \boxed{x = 2.2}$$

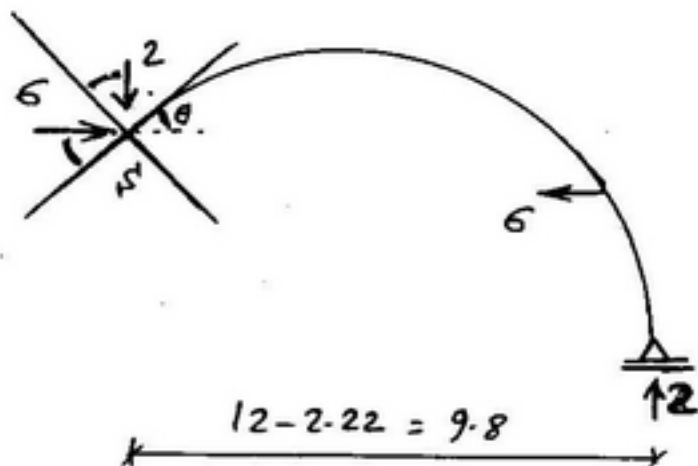
$$y' = -\frac{2x}{7.2} + 1.667$$

$$y' = \tan \theta = -\frac{2(2.2)}{7.2} + 1.667 = -1.055$$

$$\therefore \theta = -46.54$$

$$\cos \theta = 0.687$$

$$\sin \theta = +0.7258$$



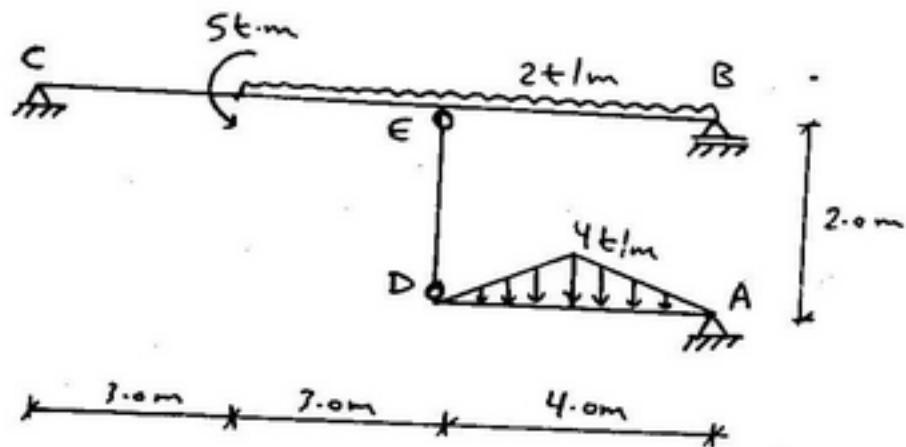
(3)

$$N_s = 2 \sin \theta - 6 \cos \theta = -2.67 \text{ ton.}$$

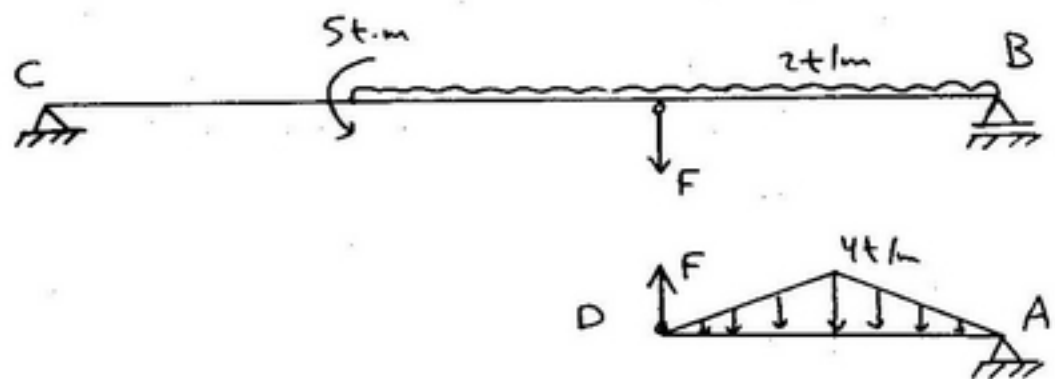
$$Q_s = -2 \cos \theta - 6 \sin \theta = -5.73 \text{ ton.}$$

$$M_s = 2 \times 9.8 - 6 \times 0 = 19.6 \text{ t.m}$$

Prob (2)

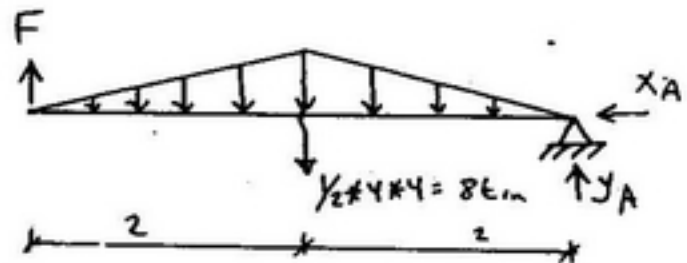


draw N.F.D , S.F.D , B.M.D  
For the following beam .



لعتبر اصحت كل جزء سائله نلوا لرمدها، اجمع فقط.

Part A-D



$$\sum X = 0 \dots$$

$$X_A = 0 \dots$$

$$\sum M_A = 0 \dots$$

$$8 \times 2 = F \times 4$$

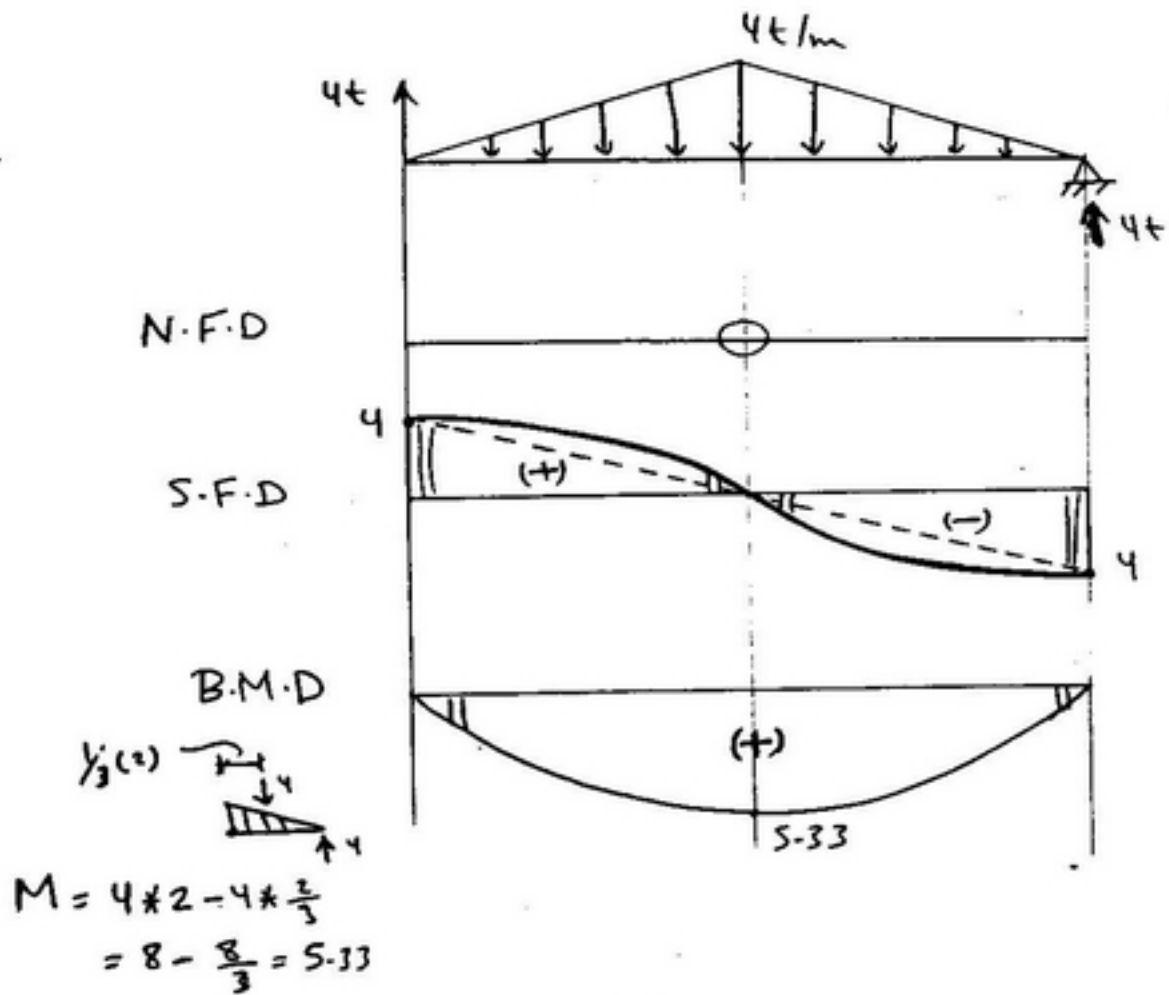
$$F = 4 \text{ ton}$$

$$\sum Y = 0 \dots$$

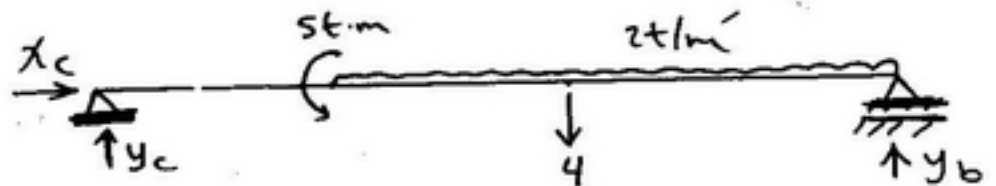
$$4 + Y_A = 8 \Rightarrow Y_A = 4 \text{ ton}$$

(7)





Par C-B



$$\sum X = 0.0$$

$$x_c = 0.0$$

(8)



$$\sum M_c = 0.0$$

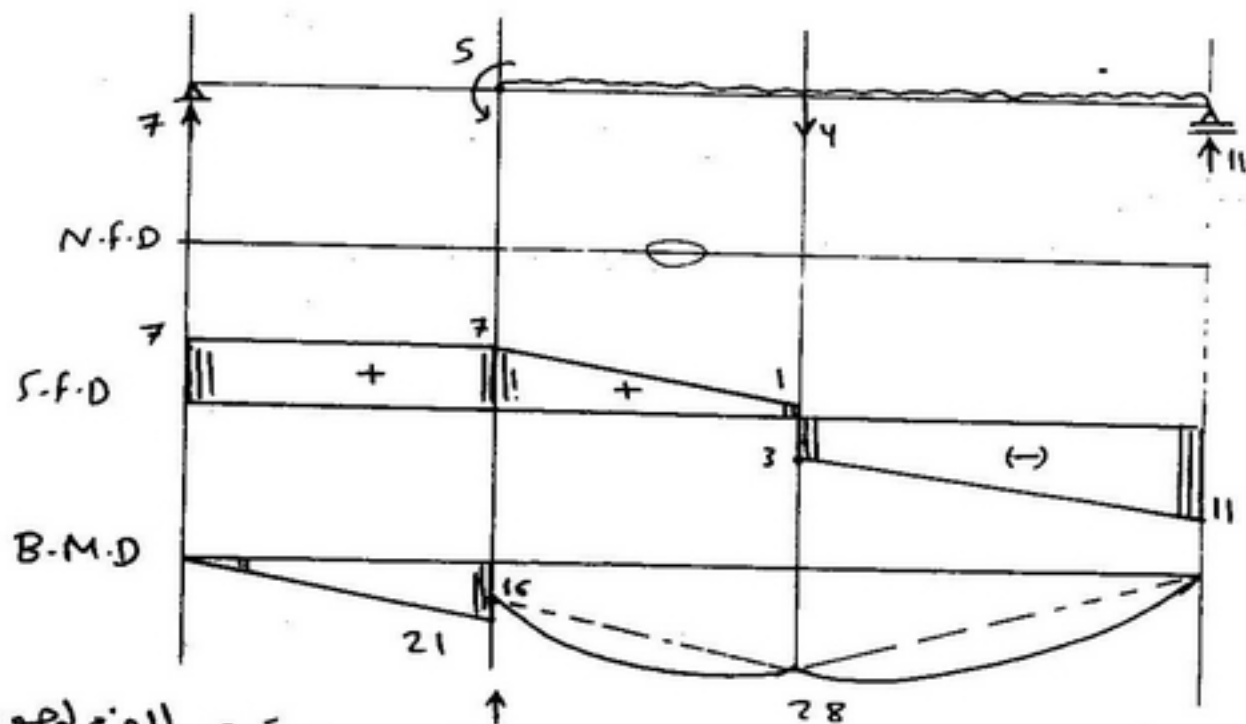
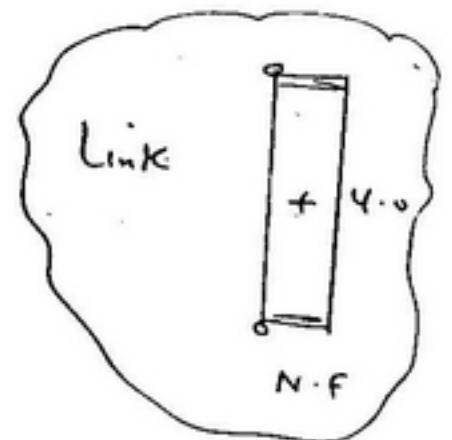
$$4 \times 6 + (2 \times 7)(3 + 3.5) = 5 + 10 \times y_b$$

$$\therefore y_b = 11 \text{ ton}$$

$$\sum y = 0.0$$

$$y_c + 11 = 14 + 4$$

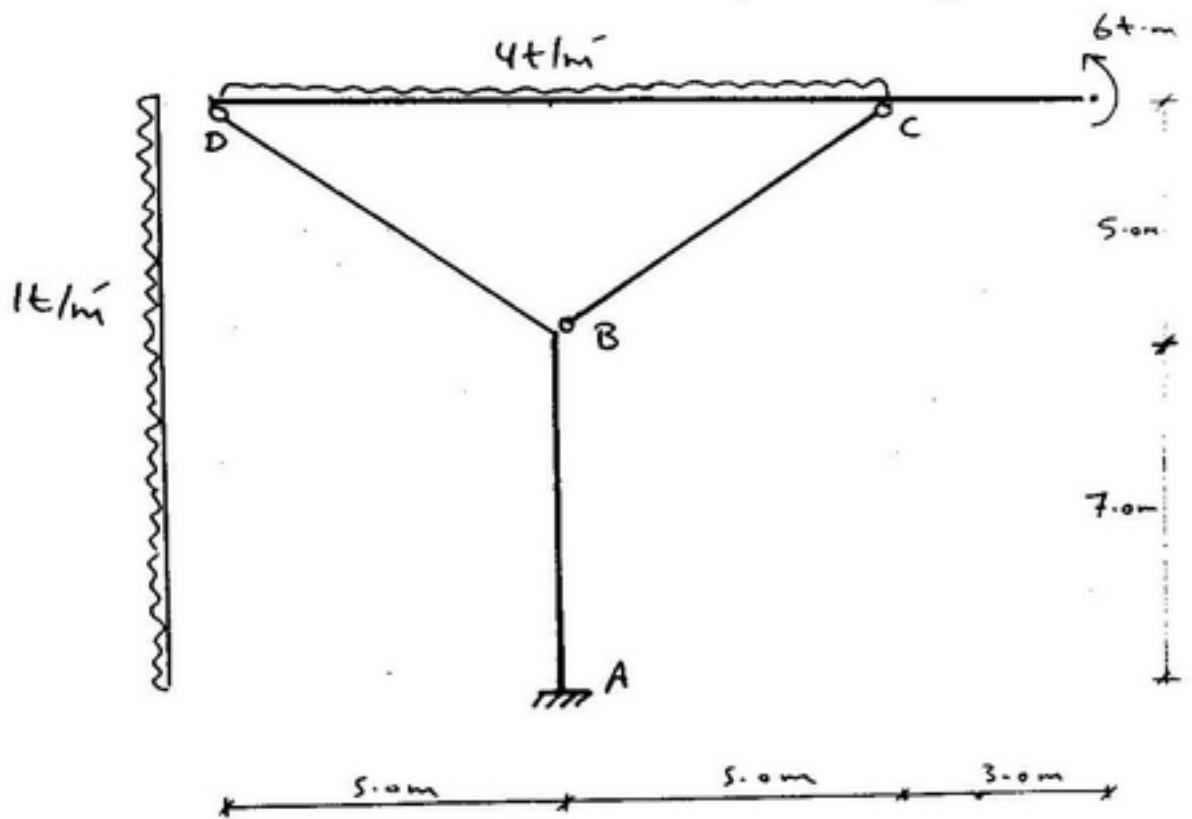
$$y_c = 7 \text{ ton}$$



فرعها لكانه بوجه قسمة للعزم لوجود  
العزم المركز على نقطة تقسمة عينة العزم  
در اصبحت استناد موقوفه موزع بعد العزم.

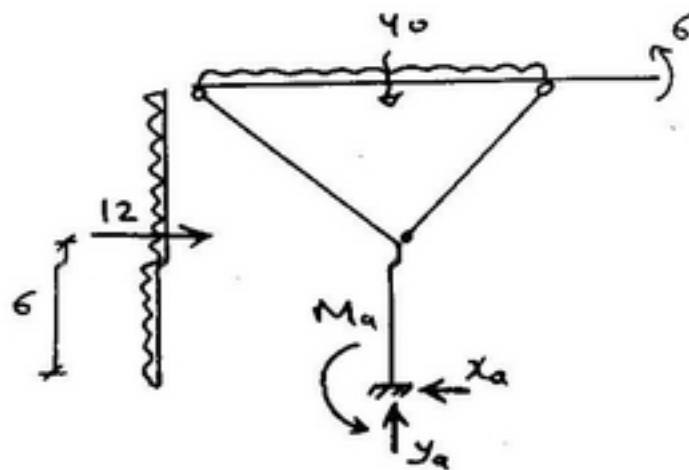
(9)

Prob 3



draw N.F.D , S.F.D , B.M.D

— 5.2 —



(10)

$$\underline{\Sigma X = 0.0}$$

$$\boxed{X_a = 12 \text{ ton}}$$

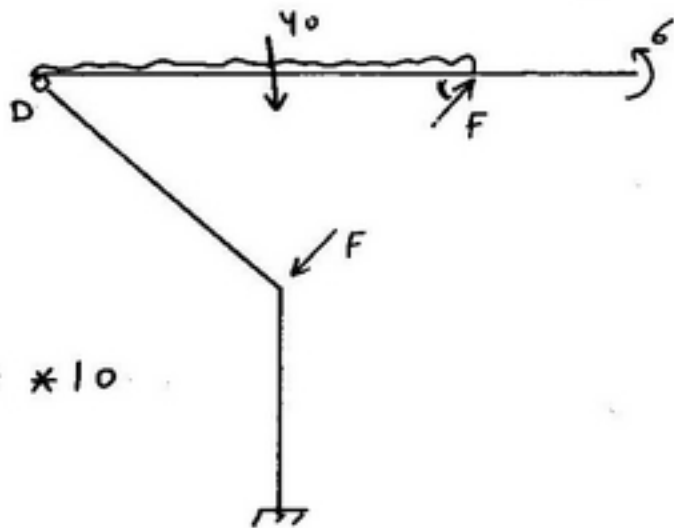
$$\underline{\Sigma Y = 0.0}$$

$$\boxed{Y_a = 40 \text{ ton}}$$

$$\underline{\Sigma M_A = 0.0}$$

$$12 \times 6 + 40 \times 0 = 6 + M_a$$

$$\boxed{M_a = 66 \text{ t.m}}$$



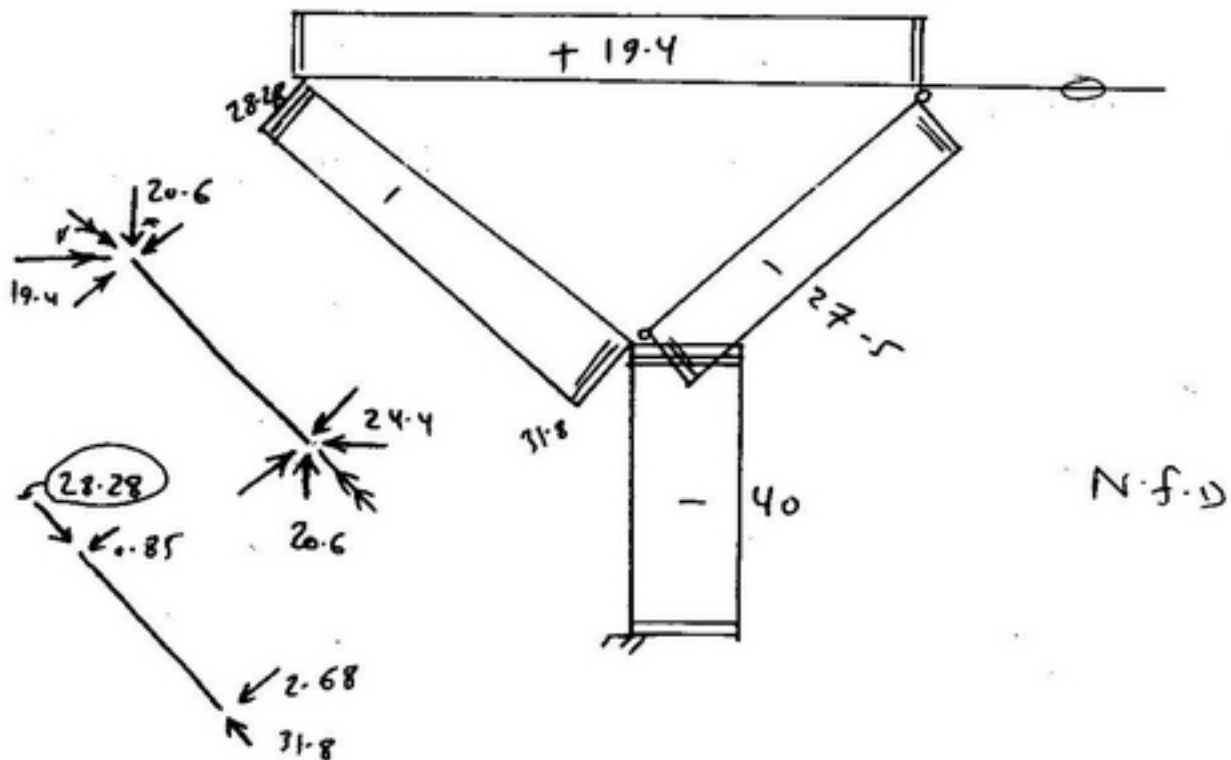
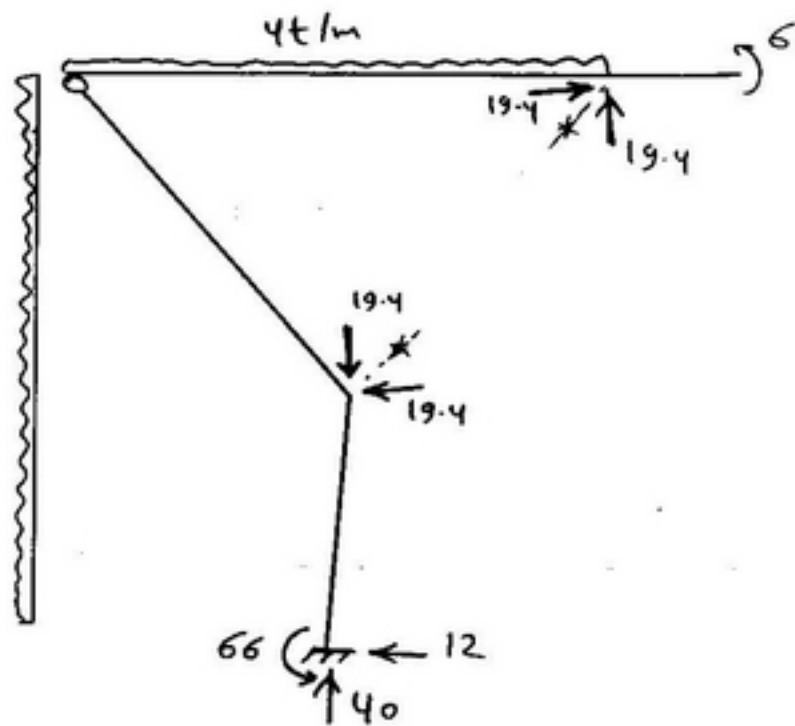
$$\Sigma M_{DR} = 0.0$$

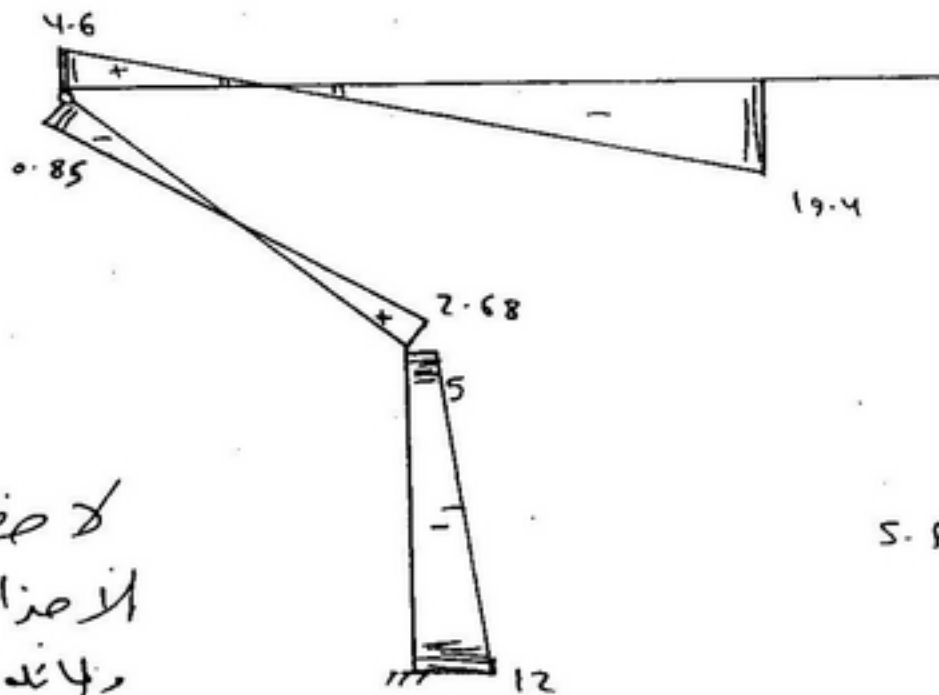
$$40 \times 5 - 6 = F \sin \theta \times 10$$

$$\sin \theta = 0.707$$

$$F = 27.5 \text{ ton}$$

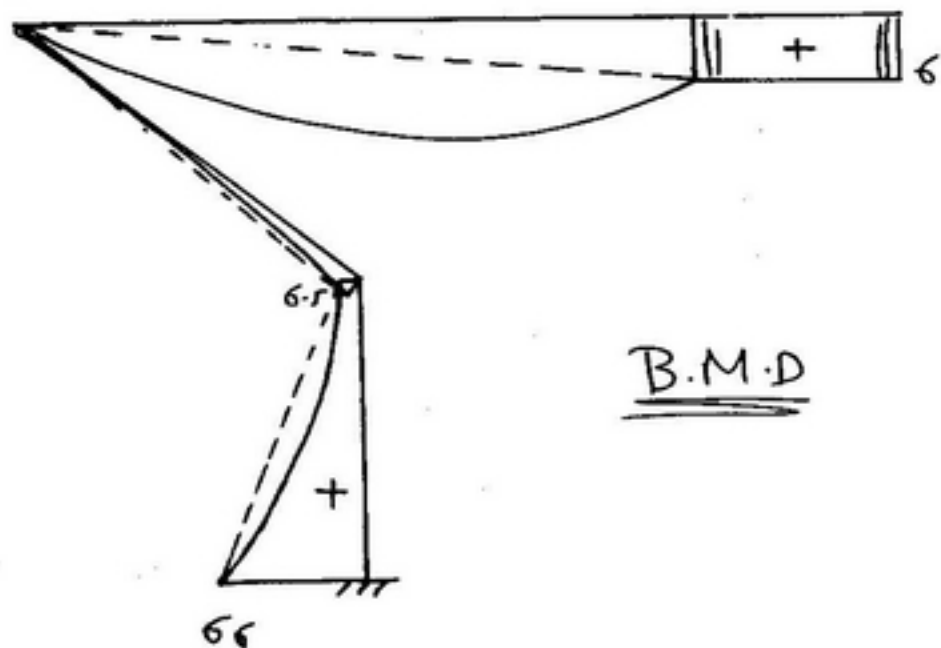
(11)





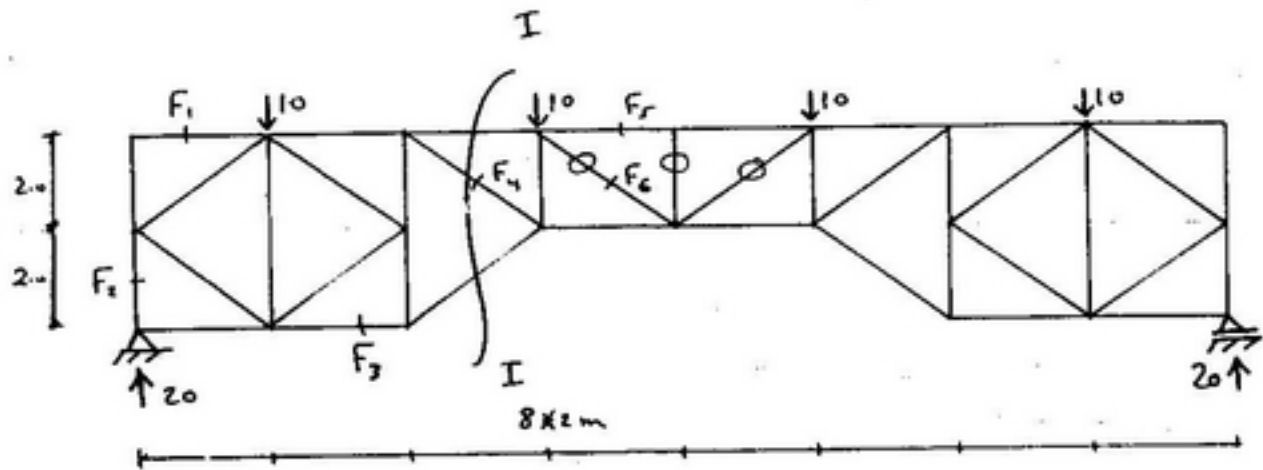
S.F.D

Shear Force Diagram  
 for the frame  
 and the values  
 are given in the  
 diagram



B.M.D

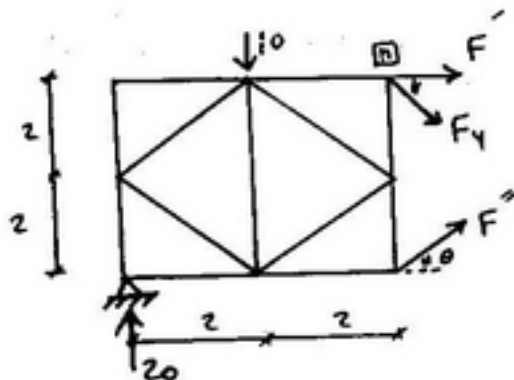
# Prob (4)



— Sol —

$$F_1 = 0$$

$$F_2 = -20$$



$$\rightarrow \sum M_n = 0$$

$$20 \times 4 = 10 \times 2 + F''(0.707) \times 4$$

$$F'' = 21.21$$

(14)

$$\underline{\Sigma X = 0.0}$$

$$F_4 \cos 45 + 21.21 \cos 45 + F' = 0.0$$

$$\boxed{F_4 + 1.414 F' = -21.21}$$

$$\underline{\Sigma Y = 0.0}$$

$$20 + 21.21 \sin 45 = 10 + F_4 \sin 45$$

$$\boxed{F_4 = 35.35}$$

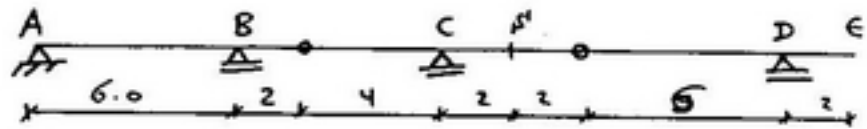
$$\therefore \boxed{F' = -40}$$

$$F_3 = F \cos 45 = 21.21 \cos 45 = \boxed{15 \text{ ton}}$$

$$\boxed{F' = F_5 = -40}$$

$$\boxed{F_6 = 0.0}$$

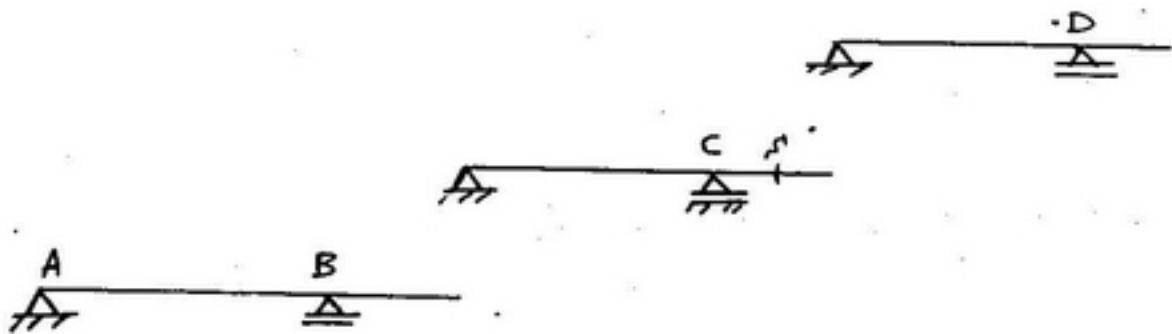
Prob (5)



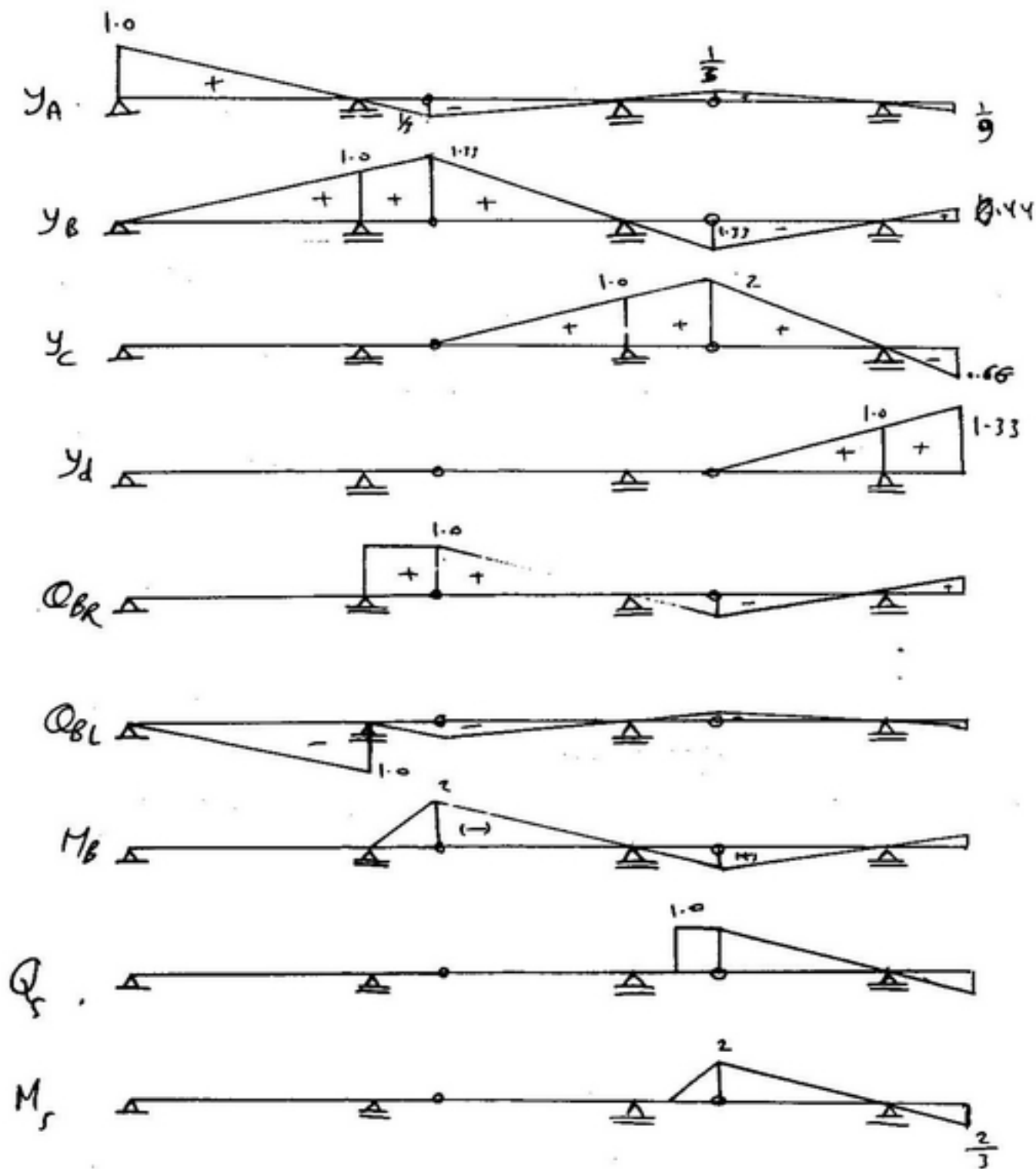
a) draw IL For  $y_a, y_b, y_c, y_d, Q_{BR}, Q_{BL}, M_B, Q_s, M_s$

b)  $Q_s$  max due to  $\downarrow \frac{24kN}{2m} \downarrow 8$

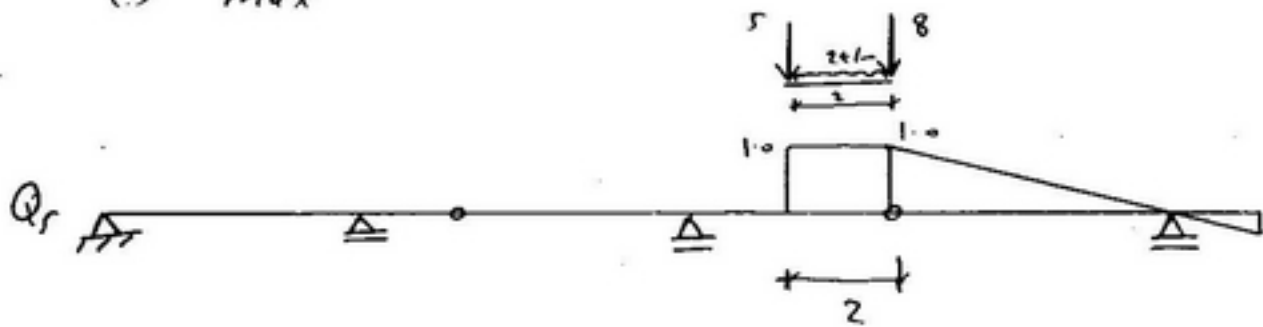
— Sol —





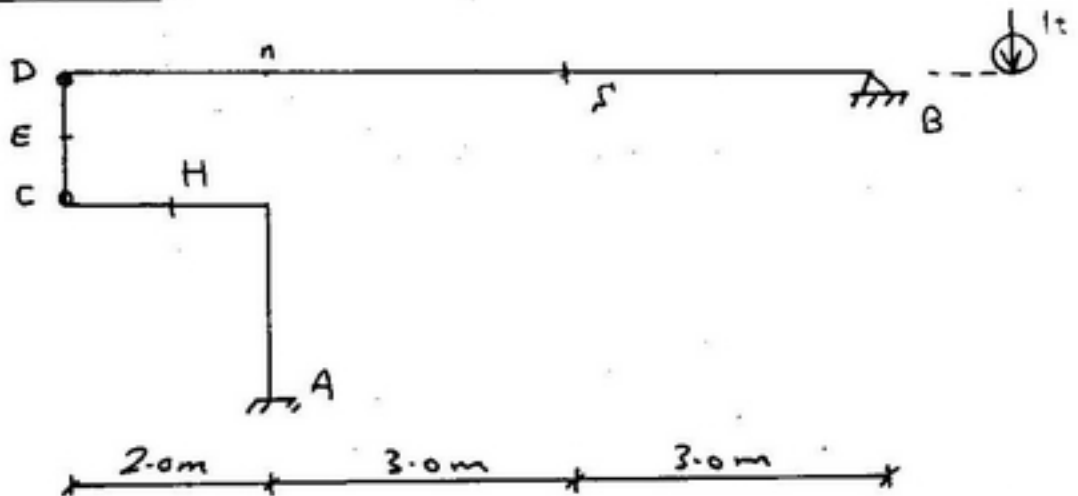


(2) max



$$\begin{aligned} Q_{max} &= 5 \times 1 + 8 \times 1 + 2 \times (1 \times 2) \\ &= 5 + 8 + 4 = 17 \text{ ton.} \end{aligned}$$

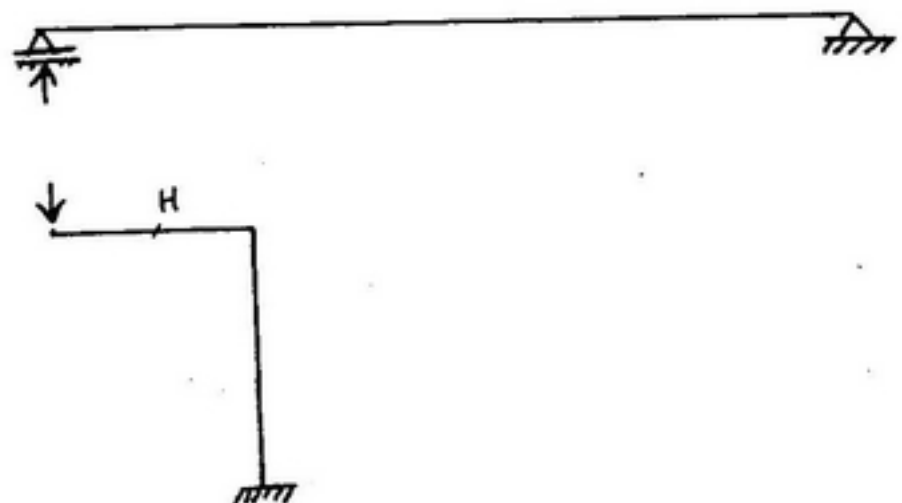
final 2006



draw

$ILY_A, Y_B, Y_D, M_A, Q_S, M_S, N_E, Q_H$   
for the shown frame.

————— Sol —————



(19)

$$IL y_A = IL y_D$$

$$IL y_B$$

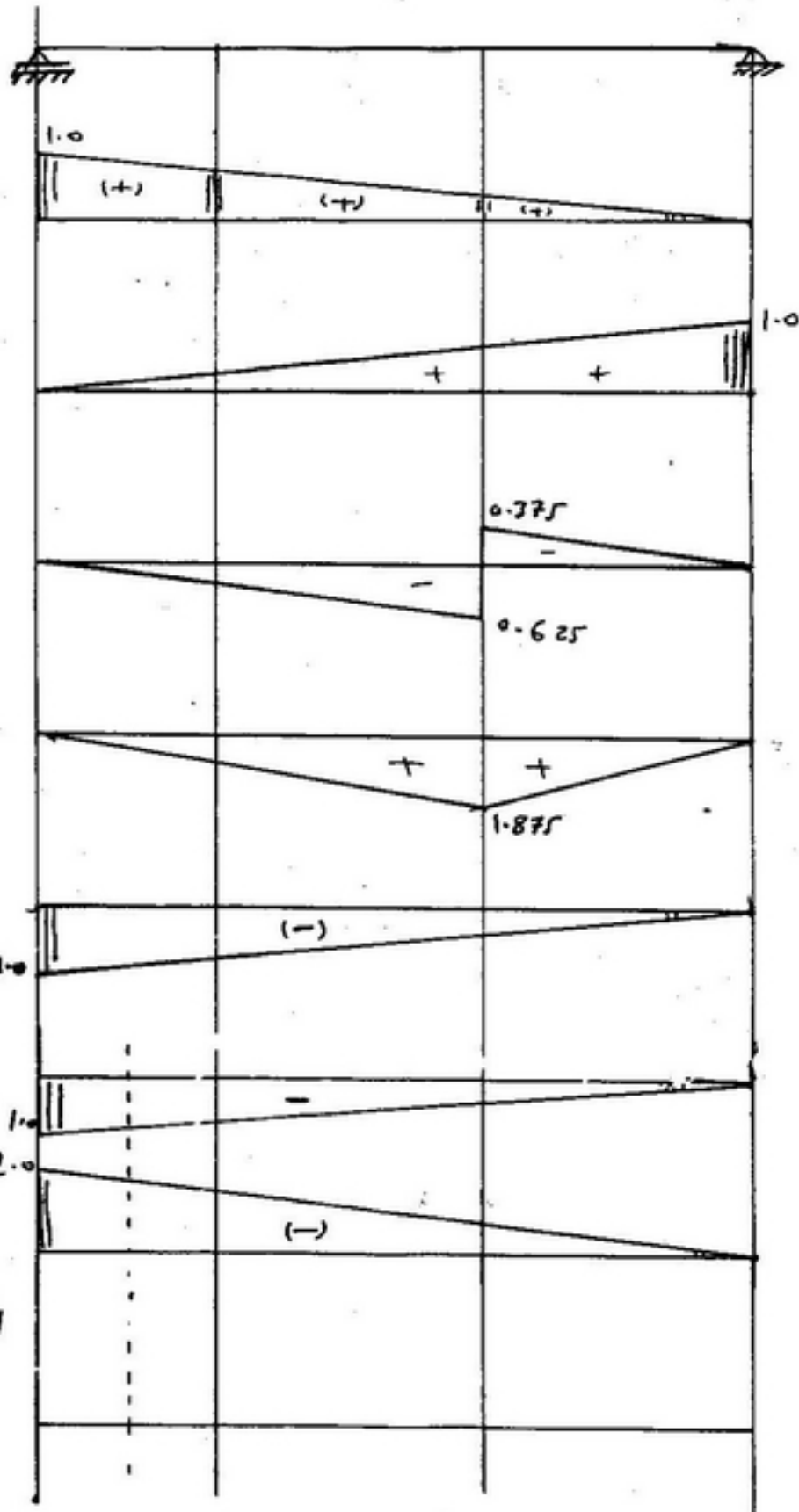
$$IL Q_r$$

$$IL M_r$$

$$IL N_e = -IL y_D$$

$$IL Q_H = IL y_d$$

$$IL M_A = 2 * IL y_d$$



(20)

Course Name : Structural Analysis  
 Course Code :  
 Level : 1<sup>st</sup>. Year - Civil Engineering  
 Department : Structural Engineering  
 Term No. : One

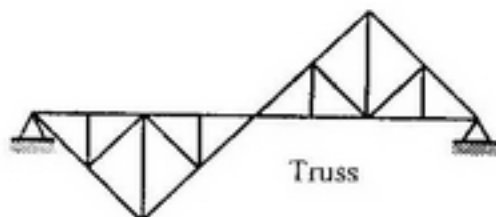
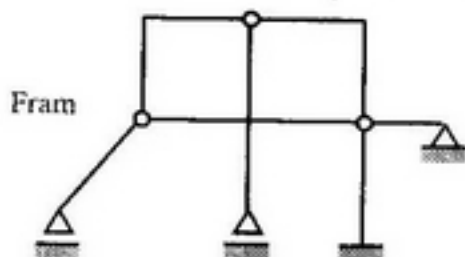


Final Term Exam  
 Date : 16/1/2008  
 Time : 3 Hours  
 No. of pages : 2  
 No. of Questions : 6

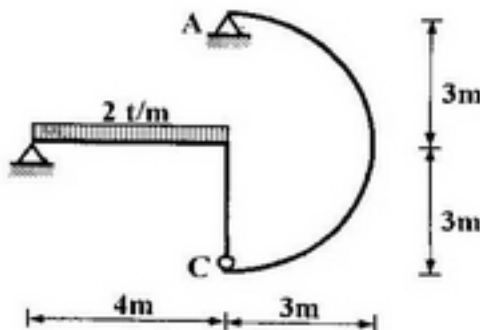
**Attempt All Problems, Full marks: 90 Marks**

**Problem No. 1 (20 Marks)**

- a) Check the stability and determinacy for the given structures. If they are unstable or statically indeterminate, show how they can be modified to become stable and determinate.

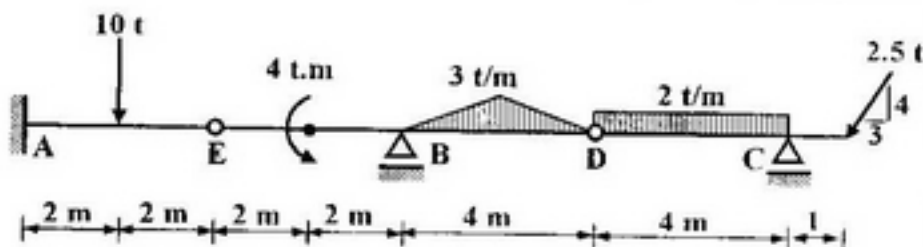


- b) Draw the N.F., S.F. and B.M. Diagrams for the given circular arch:



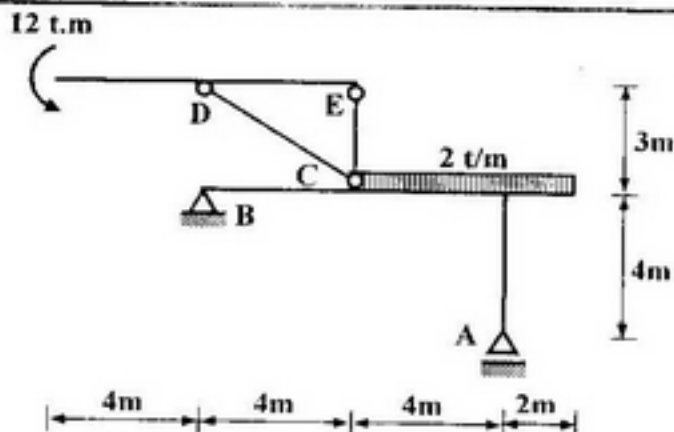
**Problem No. 2 (20 Marks)**

Draw the N.F., S.F. and B.M. Diagrams for the given beam, then, find the point on part DC at which the +ve B.M. equals the -ve B.M. at C.



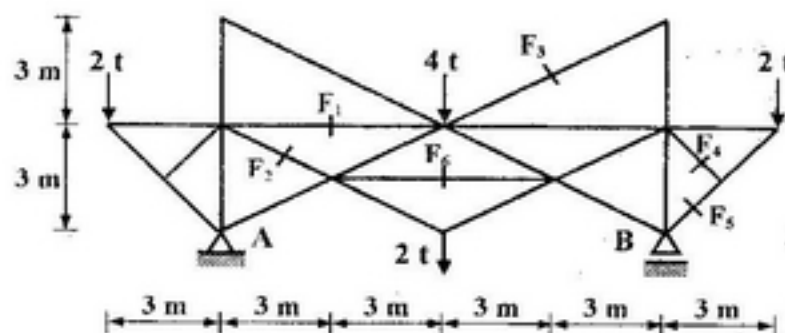
**Problem No. 3 (20 Marks)**

Draw the N.F., S.F. and B.M.Ds. for the given Frame:

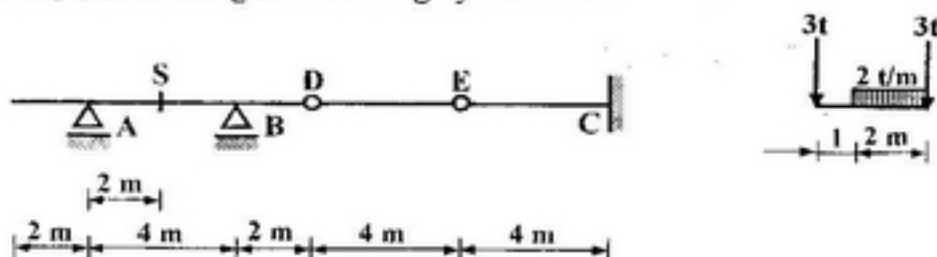


**Problem No. 4 (15 Marks)**

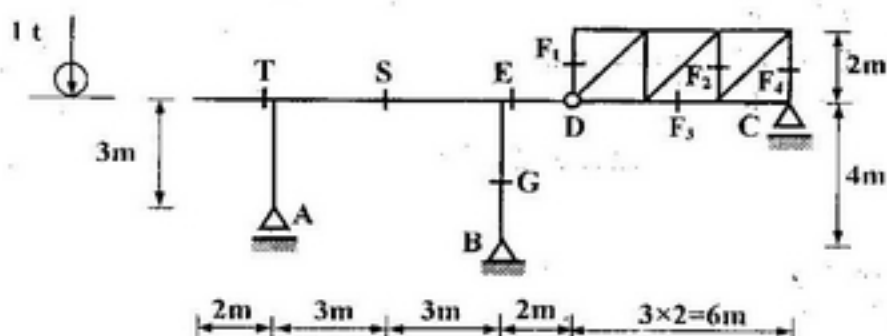
Find the forces in the marked members for the following truss:

**Problem No. 5 (15 Marks)**

- Draw the influence lines of  $Y_A$ ,  $Y_B$ ,  $Y_C$ ,  $M_C$ ,  $Q_{AR}$ ,  $Q_{BR}$ ,  $M_A$ ,  $M_B$ ,  $Q_D$ ,  $Q_S$  and  $M_S$ .
- Determine the max.  $M_S$  due to the given loading system:

**Problem No. 6 (15 Marks)**

Draw the influence lines of  $Y_A$ ,  $Y_B$ ,  $Y_C$ ,  $Q_T$ ,  $M_E$ ,  $N_G$ ,  $Q_S$  and  $M_S$  for the frame and the influence lines of the forces in the marked members of the truss:



Best Wishes,

Prof. Dr. Ashraf M. El-Shihy

Ass. Prof. Hesham F. Shaaban

Dr. Tarek M. Amin

scanner & modified & upload  
by

Mahmoud Ashraf

contact info

[titanic\\_ship1912@yahoo.com](mailto:titanic_ship1912@yahoo.com)